Wave-Particle Paradox and Evans Photomagneton.
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ABSTRACT.
Physical objects from quarks to planets have wavelike attributes. Quantum theory offers an excellent mathematical structure for the wave-particle duality nature of photons, electrons, protons, neutrons, atoms and molecules. This article explains the electromagnetic inertia harmonic oscillation nature of quantum particles and gives a simple physical interpretation of the string theory, wave mechanics, two-slit interference and the Faraday effect.

1.0 The ELECTRON.
An electron is an elementary particle with the smallest non-zero rest mass. It has a negative electric charge, which generates a field in free space, extending to infinity, and is conversely acted on by forces due to the field.

1.1 A STATIC ELECTRON (with zero velocity and zero acceleration).
It has a static isotropic, radial symmetric conservative Coulomb electric field and a zero magnetic field.

1.2 A UNIFORMLY MOVING ELECTRON (with constant velocity and zero acceleration).
It has a uniformly moving anisotropic, radial symmetric electric field and a uniformly moving anisotropic, circular symmetric induced magnetic field, which is proportional to the electron velocity. The electric and magnetic fields are orthogonal.

1.3 A UNIFORMLY ACCELERATING ELECTRON (with uniformly changing velocity and constant acceleration).
It has a uniformly changing electric field and a uniformly changing magnetic field. The electric and magnetic fields are orthogonal and in phase quadrature.

1.4 A NON-UNIFORMLY ACCELERATING ELECTRON (with non-uniformly changing velocity and variable acceleration).
It has a non-uniformly changing electric field and a non-uniformly changing magnetic field. The electric and magnetic fields are not in phase quadrature.

2.0 QUANTUM PARTICLES.
Quantum particles are never at rest. Atoms or molecules in a solid are oscillating, very nearly, in a simple harmonic motion (SHM) about their fixed mean equilibrium position even at zero kelvin temperature. Protons and neutrons in a nucleus, and quarks inside a proton or a neutron are also oscillating in a harmonic motion about their fixed mean equilibrium position.

2.1 The ELECTRON.
A static electron in free space will have no uniform motion in a straight line in a given inertial frame of reference, but is not a fixed particle at rest. It is oscillating in a SHM about a fixed mean equilibrium position, with optical frequencies.

Assume an isolated electron in free space to be at rest at the origin in a given inertial frame of reference. Let this electron be subject to a quantum force $F$ along the $(+)$ y-axis. A uniformly accelerating electron along the $(+)$ y-axis gives rise to a uniformly changing electric field. This will induce a uniformly changing magnetic field, which will induce a uniformly changing electric field, so as to oppose the initial change in the electric field. This will cause the electron to decelerate and come to rest at some point $(+a)$ on the y-axis. At point $(+a)$ on the y-axis, since the electron velocity is zero, the induced magnetic field is zero. The decelerating electromagnetic force on the electron will continue to act along the $(+)$ y-axis and cause the electron to accelerate along the $(−)$ y-axis. Since, deceleration along the $(+)$ y-axis is equal to acceleration along the $(−)$ y-axis. The electron will accelerate towards the origin. At the origin the initial force $F$ will now be acting along the $(−)$ y-axis. This force will carry the electron to a point $(-a)$ on the y-axis, where the electron will again come to rest, change direction and accelerate towards the origin. And so on…

For a uniformly accelerating electron (see #1.3), the orthogonal electric ($E$) and magnetic ($H$) fields are in phase quadrature.
This contributes to the electromagnetic inertia harmonic oscillations of the electron and the corresponding harmonic oscillating electromagnetic standing field. The electric field energy plus magnetic field energy is a constant. Petr Beckmann [1] has done a detailed analysis of the oscillating electron.

This electron oscillation behavior is in accordance with the law of conservation of energy and is similar to that of an ideal simple pendulum oscillating in a SHM in the earth’s gravitational field. The potential field vector direction and the kinetic field vector direction of the uniformly accelerating, oscillating pendulum are orthogonal and in phase quadrature. The potential field energy plus kinetic field energy is a constant. Whereas, the earth’s conservative gravitational field is external to the simple pendulum and the gravitational field of the pendulum is negligible in comparison with that of the earth; an electron in free space (zero kelvin temperature) oscillates in its own electromagnetic inertia field. This is non-thermal zero point vibration at absolute zero.

An ideal simple pendulum is either at rest or will continue to oscillate in a SHM. An electron at rest in free space, if displaced from its rest position, will continue to oscillate in a SHM. This electromagnetic inertia harmonic oscillation is as fundamental as (i) the uniform motion in a straight line, law of linear inertia or the conservation of linear momentum and, (ii) the law of rotational inertia or the conservation of angular momentum.

An ideal simple pendulum will oscillate along a linear path or, along an elliptical or a circular path (conical pendulum). Similarly, an electron can oscillate along a linear path or, along an elliptical or a circular (clockwise or anti-clockwise) path, which contributes to the electron’s intrinsic magnetic moment (up or down). This also explains Schrödinger zitterbewegung (zbw) theory to be described in #7.0 below.

2.2 The PROTON.

A proton is a quantum particle with a positive electric charge equal in magnitude to the negative electric charge of an
electron. A proton will exhibit electromagnetic inertia harmonic oscillations similar to that of an electron. The mass of a proton is about 1840 times that of an electron, and so the amplitude of a proton oscillation will be about 1840 times less than that of an electron, under similar conditions.

2.3 The NEUTRON.
A neutron is a quantum particle with a mass about equal to that of a proton. It has zero electric charge but has an intrinsic magnetic moment. It can be considered to be a quantum magnet with a N-pole and a S-pole.

Assume an isolated neutron in free space to be at rest at the origin in a given inertial frame of reference, with its magnetic NS-axis parallel to the y-axis. Let this neutron be subject to a quantum force $F$ along the (+) y-axis. A uniformly accelerating neutron along the (+) y-axis gives rise to a uniformly changing magnetic field. This will induce a uniformly changing electric field, which will induce a uniformly changing magnetic field, so as to oppose the initial change in the magnetic field. This will cause the neutron to decelerate and come to rest at some point (+b) on the y-axis. At point (+b) on the y-axis, since the neutron velocity is zero, the induced electric field is zero. The decelerating electromagnetic force on the neutron will continue to act along the (+) y-axis and cause the neutron to accelerate along the (-) y-axis. Since, deceleration along the (+) y-axis is equal to acceleration along the (-) y-axis. The neutron will accelerate towards the origin. At the origin the initial force $F$ will now be acting along the (-) y-axis. This force will carry the neutron to a point (-b) on the y-axis, where the neutron will again come to rest, change direction and accelerate towards the origin. And so on…

The uniformly changing magnetic ($H$) and electric ($E$) fields of the uniformly accelerating neutron are orthogonal and in phase quadrature. So, a neutron exhibits electromagnetic inertia harmonic oscillations similar to that of an electron or a proton.

2.4 ATOMS and MOLECULES.
Atoms and molecules are quantum particles with a zero net electric charge. Polar molecules have an electric moment. Atoms and molecules with unpaired electrons are paramagnetic and possess a magnetic moment. The atomic nucleus has an electric and a magnetic moment of its own. Nuclear magnetic moment (nuclear magneton) is 1840 times weaker than atomic magnetic moments, orbital or intrinsic, (Bohr magneton). So, an atom or a molecule exhibits electromagnetic inertia harmonic oscillations similar to that of an electron, proton or a neutron. The vibration of atoms or molecules in a solid at zero kelvin temperature is due to their own electromagnetic inertia field, which is the cause of the non-thermal zero point vibration energy at absolute zero.

2.5 The PHOTON.
A photon is an elementary particle with a zero electric charge. It either has a zero rest mass or a finite non-zero rest mass in the range, $10^{-68}$ to $10^{-45}$ kg [6]. A photon is never at rest and always moves with the speed of light. A photon has a real longitudinal magnetic field whose quantum equivalent is the Evans photomagnet, which has all the known properties of magnetic flux density (tesla). Circularly or elliptically polarized light acts as a magnet upon interaction with matter. This is the ‘inverse Faraday effect’ (IFE). Unpolarized light does not exhibit IFE. This magnetization is proportional to the light intensity [6], and the light intensity is proportional to the photon flux density, as per Einstein’s correlation of the number of photons in a light beam with its intensity. A circularly polarized laser beam of intensity $10^4$ W m$^{-2}$ (1 W cm$^{-2}$), the magnitude of the longitudinal magnetic field is about $10^{-5}$ Tesla or about 0.1 G, roughly a tenth of the earth’s magnetic field [6].

The real longitudinal magnetic field of the photon was discovered in 1992 by Professor Myron Wyn Evans* [4,5,6]. A landmark historical event with far-reaching insights in our understanding of the physical nature of the quantum world. The longitudinal electric field of a photon is imaginary, (complex numbers). The transverse orthogonal magnetic (H) and electric (E) fields of a photon are real. The photon is its own anti-
photon since it has no charge, baryon number, lepton number or strangeness. The direction of the real longitudinal magnetic field is opposite for photon and anti-photon [6]. The enigmatic photon, a quantum of electromagnetic radiation, is a magnetic dipole; it is a quantum magnet. This assumption by Rajpal will be clear as we proceed. An anti-photon is a photon with its magnetic polarity reversed, that is, from NS to SN or vice versa.

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3.0 PAIR PRODUCTION.
A photon with sufficient energy can be transformed into an electron-positron pair. The mass-energy is conserved as per Einstein’s law of equivalence of mass and energy. The photon’s magnetic charge is conserved and transforms into the electric charge of the electron and the positron. This electric charge probably results from the rotational (curl) harmonic oscillation dynamics of the quantum magnet, the photon. Just as the electron’s orbital and intrinsic magnetic moment result from the rotational dynamics of the electron. Pair production is direct conversion of radiant energy to matter. The photon has several properties that distinguish it from all other subatomic particles. It may well be the common denominator of all energy, matter and anti-matter in the universe. It is the only elementary particle wherein a high-energy photon can transform into two or more low-energy photons. This is observed in photosynthesis.

4.0 STRING THEORY.
The theory replaces point like elementary particles by one-dimensional strings. Open strings have free ends and closed strings form loops. The first suggestion of string theory was made by P A M Dirac in 1950. Yoichiro Nambu proposed his string theory in 1970 [9]. Nambu’s strings are massless, vibrating, oscillating, rotating, one-dimensional objects, which are free to split and join. The strings create their own dynamic spacetime rather than simply moving in some background space. An open string carries ‘charges’ at its end points. This is similar to #2.1 above, wherein for a linearly oscillating electron the velocity at the end points is zero. So at the end points the induced magnetic field is zero and we have the electric field only.
A simple explanation by Rajpal of the string theory is that, “a string is a harmonically moving (vibrating, oscillating, rotating, spinning, twisting) photon”. A massless photon can split, oscillate, rotate and transform into an electron-positron pair (see #3.0). The quantum dipole magnet, the photon, can also probably join to form a quadrupole, an octupole or a multipole. The different harmonic vibration, rotational and oscillation patterns (linear, elliptical or circular) of the quantum magnet, the photon, create their own dynamic electromagnetic spacetime. The additional dimensions in string theory do not relate to spacetime (4-dimensions) but to force charges, just as in the Kaluza-Klein theory the fifth dimension refers to Maxwell’s electromagnetic field. The photon motion, probably correspond to and create the different masses and force charges (electromagnetic, strong and weak nuclear interactions) of the various elementary particles.

We have seen in #2.0 above that electrons, protons and neutrons exhibit electromagnetic inertia harmonic oscillations. This explains the original string theory idea that an elementary particle is an (electromagnetic) standing wave. It also interprets: Edward Witten’s [2] view that “an electron is a little vibrating string”; Michael Green’s [2] comments that “the strings vibrate not only in space but also in time”; “the spacetime in which the string is moving is itself altered by strings”; and the additional dimensions are “not really dimensions at all” [9].

As mentioned in #2.1 above, this quantum particle electromagnetic inertia harmonic oscillations can be linear, elliptical or circular. Linear oscillations correspond to open strings and, the elliptical and circular to closed strings. As stated in #14.0 below, unpolarized light has a predominantly elliptical character. Probably, for all quantum particles, the elliptical harmonic oscillation nature dominates over linear harmonic oscillations. This will account for John Schwarz’s [2] notion as to why “closed string theories look the most promising”, and Edward Witten’s [2] observation that, “most string theories have only closed strings”. The constantly changing character of unpolarized light mentioned in #14.0 below, means that a string (that is a photon moving in one-dimension) is itself moving and tracing out a two-dimensional surface or a membrane.
5.0 INTRINSIC SPIN.

Intrinsic spin is an important characteristic of subatomic particles. It is a quantum mechanical property. An analogue in classical mechanics is probably the conical pendulum mentioned in #2.1 above; also see #7.0 below. In subatomic particles, the intrinsic spin angular momentum is quantized. It always comes in fixed discrete units that are integer multiples of $\frac{1}{2}(\hbar - \text{bar})$. For ease of expression, a particle with spin $\frac{1}{2}(\hbar - \text{bar})$ is referred to as having ‘spin $\frac{1}{2}$. Moreover, the electric charge is also quantized and comes in simple multiples of the fundamental unit of electron charge.

Paul Dirac in a classic paper (early 1930s) found that, if magnetic monopoles exist, their magnetic charge (m) would have to bear a simple relation to the fundamental unit of electric charge (e). Explicitly, $(e)(m)=(\hbar - \text{bar})$, or an integral multiple thereof [2]. An electric charge is probably the rotational (curl) harmonic oscillation dynamics of the quantum magnet, the photon. It is not something added on to a particle. Now since, the Evans photomagneton [6] is a physical constant, and the intrinsic spin angular momentum is quantized; so, it explains why the electric charge is also quantized. Moreover, just as the intrinsic spin can be up or down (clockwise or anticlockwise), so also can the electric charge be positive or negative.

A photon is a boson with an intrinsic spin of ‘1’. A photon (NS or SN) if rotated in space through 360 degrees will return to its original configuration. A proton or a neutron is a fermion with an intrinsic spin of $\frac{1}{2}$ and has to be rotated through 720 degrees before it returns to its starting configuration. A proton or a neutron probably oscillates, tracing a figure of ‘8’ as in a Lissajous’ figure in a cathode ray oscilloscope. This corresponds to a rotation of 720 degrees and also probably explains the shape of the Calabi-Yau space concept in string theory [7].

6.0 WAVE MECHANICS.

A particle at rest at the origin in a given frame of reference, when subject to a force along the x-axis, will move with a uniform motion in a straight line along the x-axis. However, a quantum particle, which is oscillating along the y-axis, in a simple harmonic motion, with its fixed mean equilibrium position at the origin; when subject to a force along the x-axis at the origin, will move along a sine wave harmonic
oscillation path in the xy-plane along the x-axis. Quantum particles do not move in a straight line, but along a harmonic oscillation path even at relativistic velocities.

The time period and frequency of a uniformly moving oscillating particle is the same as that of a stationary oscillating particle. The linear velocity depends on the force that is applied to the stationary oscillating particle. The wavelength is equal to the velocity divided by the frequency. The amplitude of a quantum particle electromagnetic wave is equal to one-half the wavelength.

An electron is a particle but its motion is described by wavelike principles. Photons propagate through space in a wavelike fashion but display particle like behavior during emission and absorption. An electron or a photon does not move in a straight line but along a sine wave harmonic oscillation path. The wavelength (or twice the amplitude) of gamma rays and x-rays photons is in the range, \(10^{-13}\) to \(10^{-9}\) metre, and so they behave more like particles moving in a straight line. For microwaves and radio waves photons, the wavelength (or twice the amplitude) is in the range, \(10^{-3}\) to \(10^{5}\) metre, and so they display more of wave like attributes. The wavelength (or twice the amplitude) of visible light photons is in the range, \(10^{-7}\) to \(10^{-6}\) metre, and they exhibit dual wave-particle nature.

For 3 cm wavelength microwaves (linearly polarized), a wire-grid with a spacing of about 7-8 mm, roughly one-quarter of a wavelength; the grid is completely transparent only when the wires are parallel to the transverse magnetic (H) field vector direction of the microwaves [10]. This shows that a photon oscillates in the transverse magnetic (H) field vector direction unlike the electron, which oscillates in the electric (E) field vector direction. Similarly, a proton oscillates in the electric (E) field vector direction and a neutron oscillates in the magnetic (H) field vector direction.

The transverse orthogonal magnetic (H) and electric (E) fields of a photon are in phase quadrature. This contributes to the electromagnetic inertia harmonic oscillations of the photon. The mathematical symmetry of the free space Maxwell’s equations, imply that the magnitudes of the transverse orthogonal magnetic (H) and
electric (E) fields are physically equivalent. However, their numerical values in SI units are not equal since, the permeability and permittivity of free space have unequal numerical values in SI units.

7.0 ZITTERBEWEGUNG (ZBW).
A theory proposed by Schrödinger (1930), zitterbewegung (zbw) is a German word for jitter motion. Zitterbewegung is a local circulatory motion of the electron presumed to be the basis of the intrinsic spin and magnetic moment. Zbw provides a physical interpretation for the complex phase factor in the Dirac wave function. Zbw is a real physical phenomenon and corresponds to a particle going along a cylindrical helix in real space with a diameter equal to Compton wavelength. David Hestenes [8] has written extensively on the zbw theory and his articles are also available on the web.

8.0 ATOMIC ORBITAL.
Electrons in atomic orbits do not move in a simple circular path but along a sine wave circular path [1]. For a uniformly accelerating electron (see #1.3), the orthogonal electric (E) and magnetic (H) fields are in phase quadrature. This contributes to the electromagnetic inertia harmonic oscillations of the orbiting electron. For stable electron orbits, the circumference is an integral multiple of the electron wavelength. This ensures that the electromagnetic field oscillates in space and time but does not travel in space and time. It is a standing wave.

For a non-uniformly accelerating electron (see #1.4), the orbits are unstable, since, the electric (E) and magnetic (H) fields are not in phase quadrature. The electron emits or absorbs a photon, a quantum of energy, and achieves a stable condition of a uniformly accelerating electron (see #1.3), wherein the electric (E) and magnetic (H) fields are in phase quadrature.

9.0 De BROGLIE WAVELENGTH.
The de Broglie wavelength of a tiny dust particle weighing one microgram and moving with a velocity of one millimeter per second is $6.6 \times 10^{-12}$ angstrom. For heavier particles moving at higher velocities, the wavelength decreases. So, macro particles appear to be moving in a straight line. But, in reality nothing moves in a straight line. The de Broglie wavelength of the planet earth moving in an
elliptical orbit around the sun can be calculated, and is $3.7 \times 10^{-63}$ m; just as we can do so for an electron in a one-proton hydrogen atom.

10.0 DIFFRACTION.
The diffraction behavior of photons, electrons, protons, neutrons, atoms and molecules is elastic scattering of quantum particles moving along a sine wave path and not in a straight line. This sine wave harmonic oscillation path of quantum particle travel makes it easy to visualize the following:

10.1 Diffraction or the elastic scattering of photons, electrons or neutrons by the periodic structure of the atoms in a crystal.

10.2 Why the angular width of the diffraction pattern increases as the slit width decreases?

10.3 Why the diffraction width is directly proportional to the amplitude or wavelength?

The pinhole diffraction of a ray of linearly polarized photons from a wavelength aperture will be along the transverse magnetic field vector direction and have an angular spread of 90 degrees [11]. The ray must be at the center of the aperture.

11.0 INTERFERENCE.
We will first consider what happens to photons traveling through a single slit and then move on to two-slit interference.

11.1 SINGLE SLIT.
Imagine seven horizontal parallel rays of light traveling in the x-axis direction, in a horizontal xz-plane; through a vertical slit (y-axis) with a slit width of 7-wavelengths (from $z=-3.5$ to $z=+3.5$). Let the rays be numbered from #1 to #7 with ray #4 in the middle (x-axis). Rays #3, #4 & #5 ($z = -1, 0 & +1$) will travel straight through the slit onto the screen. Rays #1 & #7 ($z = -3 & +3$), being close to the slit walls, will experience diffraction due to elastic scattering since; the photons are traveling along a sine wave harmonic oscillation path and not in a straight line. Photons traveling along rays #2 & #6 ($z = -2 & +2$) will experience some diffraction due to elastic scattering of photons in the neighboring rays #1 & #7 ($z = -3 & +3$).
11.2 TWO-SLIT INTERFERENCE.

Figure below represents eight photons of unpolarized light traveling along a horizontal ray in the x-axis direction. Neighboring photons have opposite magnetic polarity; so, unpolarized light does not exhibit magnetism on interaction with matter.

(N)  (S)  (N)  (S)  (N)  (S)  (N)  (S)
(S)  (N)  (S)  (N)  (S)  (N)  (S)  (N)

Figure below represents eight vertical parallel (y-axis) coherent rays of unpolarized light traveling in the y-axis direction. Each ray has four photons. In a coherent beam all rays are in phase. Neighboring photons in the horizontal xz-plane, in adjoining rays, the magnetic polarity is such that unlike magnetic poles face each other, and so attract each other. Photons thereby, exhibit a bunching tendency, a property shown by all bosons.

(NS)  (NS)  (NS)  (NS)  (NS)  (NS)  (NS)  (NS)
(SN)  (SN)  (SN)  (SN)  (SN)  (SN)  (SN)  (SN)
(NS)  (NS)  (NS)  (NS)  (NS)  (NS)  (NS)  (NS)
(SN)  (SN)  (SN)  (SN)  (SN)  (SN)  (SN)  (SN)

Figure below represents two vertical rays of unpolarized light traveling in the y-axis direction. Each ray has two photons, as shown. The two adjoining photons are out of phase by 180 degrees. These two adjoining photons will repel each other since, like magnetic poles repel each other.

(NS)
(SN) (NS)
(SN)

In a double slit interference experiment, two photons after being diffracted and traveling from the two slits towards the screen, along two convergent rays of light; if on arrival at a point on the screen, are out of phase by 180 degrees, will repel each other and get deflected to neighboring areas, thereby creating a dark band between two bright neighboring bands. This explains Thomas Young’s interference experiment (1801).
12.0 **HANBURY-BROWN and TWISS (HBT) EXPERIMENT.**

It is reported that two-slit interference occurs even when the intensity is reduced so much that only one photon or electron traverses the apparatus at a time. However, Robert Hanbury-Brown and Richard Q. Twiss have observed in their experiment (1956) that photons, in a coherent beam, are not emitted one at a time at equal intervals. Photons in a coherent beam, travel in bunches or groups and not as separate individual particles at equal intervals. The HBT experiment has been well explained by Akira Tonomura [13]. Moreover, only coherent radiation creates an interference pattern.

Electrons are fermions and obey the Pauli exclusion principle but electron pairs have zero spin and behave like bosons. Vacuum or free space temperature is zero kelvin. So, electrons in free space move in pairs, just as they do in a superconductor at a few degrees above zero kelvin. This bosonic behavior explains electron interference.

13.0 **ELECTRON INTERFERENCE.**

In an electron-ray neighboring electrons have opposite intrinsic spin (up or down). Just as in a light ray neighboring photons have opposite magnetic polarity (NS or SN) as observed in #11.2 above. In a coherent electron beam neighboring electrons in adjoining rays have opposite intrinsic spin (up or down). Just as in a coherent light beam neighboring photons in adjoining rays have opposite magnetic polarity (SN or NS). Electron interference is thus similar to photon interference as explained in #11.2 above. When we observe, as to which one of the two slits the electron is traveling through, we disturb the coherence in the beam and so interference does not occur.

14.0 **POLARIZATION.**

Polarization is of three types: linear, circular and elliptical. Elliptical polarization includes the other two as special cases. Natural unpolarized visible light has an appreciable bandwidth. It includes all three types of polarizations. The most prominent feature of unpolarized light is its constantly changing, predominantly elliptical, character [12].

1. **LINEAR POLARIZATION.**
In linear polarization, the transverse magnetic field vector is not confined to a single plane of vibration, but has an angular spread of 90 degrees [11].

14.2 CIRCULAR POLARIZATION.
In circular polarization the transverse magnetic (H) and electric (E) field vectors rotate rather than oscillate as in linear polarization. In both cases the transverse magnetic (H) and electric (E) fields are orthogonal and in phase quadrature. In a ray of circularly polarized light, photons travel along a circular (clockwise or anti-clockwise) helix or spiral path of wavelength diameter, or radius equal to the amplitude. All photons in a ray have their magnetic polarity (NS or SN) at 45 degrees to the centerline of the spiral. The longitudinal vector components, of the Evans photomagnetons, add up to give a net resultant longitudinal magnetic field. This explains the ‘optical Faraday effect’ (OFE) and similar magneto-optical effects. The OFE is the rotation of the plane of polarization of a linearly polarized probe beam by a second, circularly polarized, pump laser. The latter substitutes for the magnetic field of the ordinary Faraday effect.

The OFE was reported to be ten times greater in magnitude in circular than in linear polarization [6]. Circularly polarized pumping was an order of magnitude more effective than linearly polarized pumping. In linear polarization, the net real longitudinal magnetic field is zero [5]. So, it should not exhibit any IFE and therefore should not display any OFE. But, the fact is that it does. This goes to show that linearly (open strings) polarized light is mostly elliptically (closed strings) polarized light with a very high degree of ellipticity. This supports the observed string theory view stated in #4.0 above that, most string theories have only closed loops.

15.0 PHOTON’S MOMENTUM.
Radiation pressure is exerted by unpolarized or linearly polarized photons in the direction of photon travel. This is due to the photon’s linear momentum. In a similar manner a mechanical torque is produced by circularly polarized photons. This was observed in an
experiment by R A Beth in 1936 [12]. This is due to the photon’s orbital angular momentum.

16.0 The FARADAY EFFECT.
The Faraday effect or the Faraday magneto-optic rotation is the observed rotation of linearly polarized light passing along a rod of very dense glass, or certain other substances, placed along the axis of a strong magnetic field. If the rotated beam is reflected back towards the source, the rotation is not reversed on the return trip and thus cancelled out, but occurs again so that the rotation is doubled. This may seem paradoxical because light passing the opposite way in the same field is then being rotated the opposite way. This shows, it is not the material of the glass, but the light photon has some directional property across its line of travel [10].

Reflection of a photon involves a 180 degrees change of phase. The NS photon on reflection becomes a SN photon or vice versa and so does not reverse its path after reflection. However, in case of internal reflection no phase change occurs and the photon on reflection will retrace its original path.

17.0 The EINSTEIN-PODOLSKY-ROSEN (EPR) EXPERIMENT.
It is a thought experiment (1935) due to Albert Einstein, Boris Podolsky and Nathan Rosen. The experiment seeks to look at both the position and momentum of a particle simultaneously [3].

If a photon source placed at the origin in a given frame of reference emits a pair of photons, simultaneously in the opposite direction, say, along the (+) x-axis and the (-) x-axis, the polarization [11] of either photon is orthogonal to that of the other. This has been observed by Alain Aspect in an experiment (1982) wherein pairs of photons are emitted in opposite directions by a quantum source and then separately have their polarizations measured many metres apart.

The magnetic polarity of either photon is opposite to that of the other. If the (+) x-axis photon polarity is NS then, the (-) x-axis photon polarity is SN or vice versa. Either photon will maintain its polarity and polarization independent of the other unless acted upon by an external force to change it.
18.0 SUMMARY.

18.1 Quantum particles exhibit electromagnetic inertia harmonic oscillation and travel along a sine wave harmonic oscillation path and not in a straight line.

18.2 A photon is a magnetic dipole. It is an elementary magnet. Evan’s discovery of the photon’s longitudinal magnetic field in 1992 is as significant, at the quantum level, as Einstein’s discovery of relativity at the universe level. It helps in giving a physical interpretation of the string theory, wave mechanics, two-slit interference and the Faraday effect.

18.3 A string is a harmonically moving (vibrating, oscillating, rotating, spinning, twisting) photon.

REFERENCES.


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