

# New Quantum Theory

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## Abstract

Quantum Theory with Wave Particle Duality is unable to explain how the phenomena of refraction, interference & diffraction, actually occurs and why 'the waves behave as particles' or 'the particles behave as waves'? **New Quantum Theory** explains that every photon has an eccentric nucleus and is always spinning. *This theory can explain all the phenomena of Electro Magnetic Radiations/Light, solves the mystery of Wave Particle Duality, and Photon has mass and sometimes can be considered as mass less.*

**Keywords:** Photon, Nucleus, Spinning Photon, Eccentric Nucleus, Angular Momentum

## 1. INTRODUCTION

The electromagnetic radiations (EM Radiations) includes radiations from long to short wavelengths along with visible light which is only a small fraction of whole spectrum of EM Radiations.

**Particle Nature:** "The Corpuscular Theory of Light by Sir Isaac Newton" states that light is made up of small discrete particles called "corpuscles" (little particles) which travel with finite velocity and possess kinetic energy. "The photoelectric effect first observed by Heinrich Hertz in 1887" (Hertz, 1887) emitting electrons from the matter as a consequence of their absorption of energy from EM Radiations of very short wavelength indicates the particle nature of light. "Max Planck's derivation" of the law of black body radiation, (Planck, 1901) assumes that luminous energy can be absorbed or emitted only in discrete amounts, called **quanta**. In 1902 Philipp Lenard discovered that energy of electrons in photoelectric effect does not depend on the intensity of the light, but depends on the wavelength of the light. Albert Einstein paper "On a Heuristic Viewpoint Concerning the Production and Transformation of Light" (Einstein, 1905) justified the quanta as energy consisting of a finite number of energy quanta localised at different points in space. The Raman Effect "A New Type of Secondary Radiation" discovered by Sir C.V.Raman also confirms that the light is made of particles (Raman, 1928).

**Wave Nature:** In 1678, Christiaan Huygens (Huygens, 1678) believed that light was made up of waves vibrating up and down perpendicular to the direction of the light travelled. "The double slit experiment by Thomas Young in 1801" supported the wave theory of light by Christiaan Huygens. The actual distribution of brightness can be explained by the alternately additive and subtractive interference of waves.

**Quantum Theory:** Electric charge is accompanied by magnetic field was first observed on 21 April, 1820 by Hans Christian Oersted. James Clerk Maxwell first presented "classical electromagnetic theory" (Maxwell J C, 1865) with derivations uniting observations, experiments, equations of electricity,

magnetism and optics into a consistent theory. "Maxwell's equations demonstrated that electricity, magnetism and even light are all manifestations of the electromagnetic field". The existence of electrical and magnetic fields together is also confirmed by Biot-Savart law, Ampère's circuital law, Gauss's law for magnetism and Faraday's law of induction etc.

Max Planck in his derivation of his law of black body radiation in 1900" formulated the fundamental principles of quantum mechanics, this postulates EM Radiations are emitted as quanta. The experiments by "Compton on scattering of X-rays on electrons" (Compton, 1923) proved that Einstein's light quanta behave as particles, carrying not only energy, but also momentum. "The term "photon" for particles of light was coined in 1926 by Lewis in an article "The Conservation of Photons" (Lewis, 1926). The photons have intrinsic charge, mass and spin. "The Experimental proof of the Spin of the Photon" was illustrated by Sir C.V.Raman and S. Bhagvantam" (Raman, 1931). L.B.Okun in "Photon: History, Mass & Charge" (Okun, 2006) has elaborated about mass and charge of photons.

There is ambiguity about the mass of photon. Existing theories consider photons to be mass less but do have momentum. So far there is no experimental proof that photon is mass less.

All the above theories indicate that EM Radiations are discrete particles called photons or quanta of energy consisting of mass, charge and spin. Photon particles have capability to travel as wave carrying electrical and magnetic fields perpendicular to each other and also to the direction of travel.

## 2. New Quantum Theory

New Quantum Theory states that:

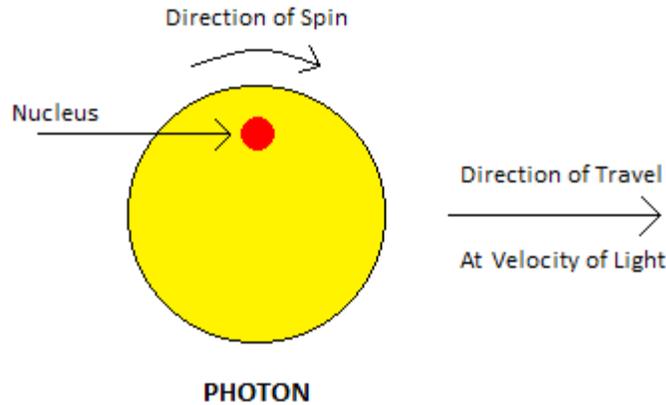
- A photon has a nucleus
- Mass of photon is concentrated in the nucleus
- The charge of photon is located in the nucleus
- Nucleus is not in the centre but located eccentrically in the photon

- Photon is always spinning
- Spinning speed is proportional to the frequency & energy of photon and inversely proportional to the wavelength

**2.1 Photon**

An enlarged view of photon is shown in Figure 1.

**Fig.1.** showing one photon as bigger yellow circle with one nucleus of concentrated mass as small red circle, the photon is spinning clockwise and travelling with velocity of light



*The spinning photon with heavy nucleus located eccentrically explains all the phenomena and properties of EM Radiations as particle nature as well as wave nature and solves the mystery of wave particle duality of the whole spectrum of EM Radiations.*

**2.2 Whether Photon has mass or is mass less**

One of the most important questions in quantum physics regarding the mass of photon is answered below:

The photon has been considered as mass less in modern quantum physics; however photon has to have mass how so ever small it may be.

- Photons have momentum which is a product of mass of photon and linear and angular velocity.
- Photons have energy. As per mass-energy equivalence equation by Albert Einstein  $E = mc^2$  it should have equivalent mass.
- The Sun is continuously losing mass by several solar phenomena including loss of mass by solar radiations in the form of photons.
- L.B.Okun in “Photon: History, Mass & Charge” (Okun, 2006) mentioned the citation of photon mass by Particle Data Group as under:  
 $2 \times 10^{-16}$  eV in 2002 by Lakes  
 $6 \times 10^{-17}$  eV in 2004 by Ryutov
- High energy photons can scatter electrons (Compton scattering).
- High frequency photons like ultra violet photons can emit electrons from metals or non-metals as photoelectrons (photoelectric effect).
- Photons exhibit the phenomena of refraction, interference and diffraction etc.
- Photons are not continuous but separate quantas having

electromagnetic force.

Assuming mass of photon as  $6 \times 10^{-17}$  eV indicated by Ryutov the mass of photon can be calculated as under:

$$E = 6 \times 10^{-17} \text{ eV} = 6 \times 10^{-17} \times 1.60217646 \times 10^{-19} \text{ joules}$$

$$= 9.6130584 \times 10^{-36} \text{ kg m}^2\text{s}^{-2}$$

$$m = E/c^2$$

$$= 9.6130584 \times 10^{-36} \text{ kg m}^2\text{s}^{-2} / (2.99792458 \times 10^8 \text{ ms}^{-1})^2$$

$$= 1.069597 \times 10^{-52} \text{ kg}$$

The scientists have considered photon to be mass less in quantum theory. Their postulation is also justified in view of the structure of the photon shown in Fig. 1 of New Quantum Theory. Consider pollen of seed with extremely light weight furs having a mass of seed located at the centre, this behaves like mass less and freely flying in air due to overall large volume of the pollen. Similarly photon has a small nucleus of mass with much larger overall volume behaving like mass less photon.

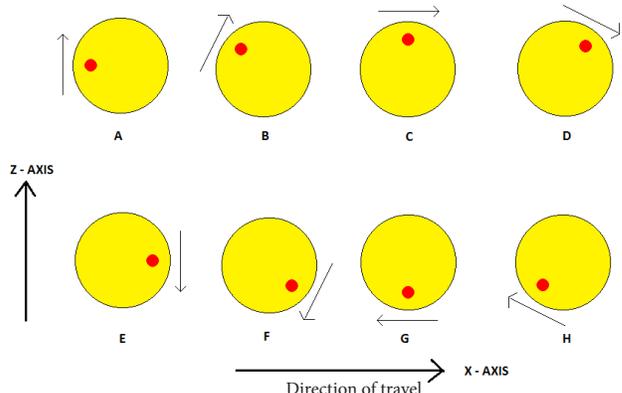
**3. Wave Formation by a Photon**

A photon has mass, charge and spin. As the photon travels in direction x (say horizontal direction) and spins clockwise, the heavy mass nucleus also rotates in x – z plane (vertical plane). Two momentum acts on photon simultaneously. The linear momentum (Mass x Velocity) is in x direction (direction of travel of photon). The angular momentum (Moment of Inertia x Angular Velocity) acts in x - z plane due to the spin of photon having eccentric heavy nucleus. The direction of angular momentum is changing continuously in x - z plane as the photon spins. The resultant direction of angular momentum and linear momentum also changes continuously in x - z plane.

This angular momentum due to the eccentric heavy nucleus of spinning photon is responsible for the up and down movement of photon in  $\pm z$  direction in x – z plane while the photon is travelling in x direction making a sinusoidal wave.

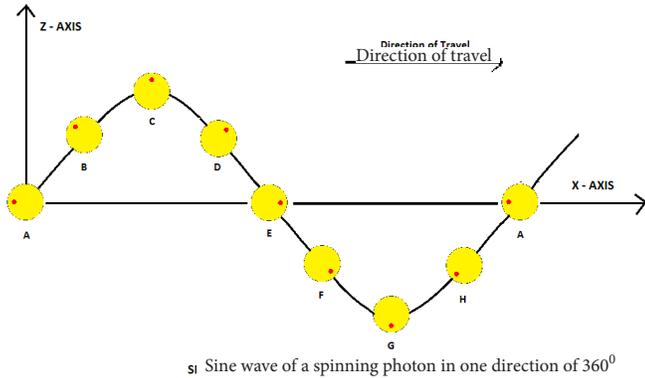
The different positions of photon after 45° rotations during one spin (360° rotation) along with direction of angular momentum are shown in Figure 2.

**Fig.2.** Position ‘A’ shows the location of nucleus at the start of sinusoidal wave and the photon is moving upwards. Subsequent positions from ‘B’ to ‘H’ are after the spin of photon by 45° each. The direction of angular momentum is shown by arrow in different positions. Direction of linear momentum is the direction of travel x - direction.



During one complete spin ( $360^\circ$  rotation) of the photon, the heavy nucleus also completes one full circle of  $360^\circ$  inside the photon. The different positions of photon after  $45^\circ$  spin each during the formation of a sinusoidal wave with eccentric spinning of the photon due to its nucleus and up & down movement of the photon in  $x - z$  plane are shown in Figure 3.

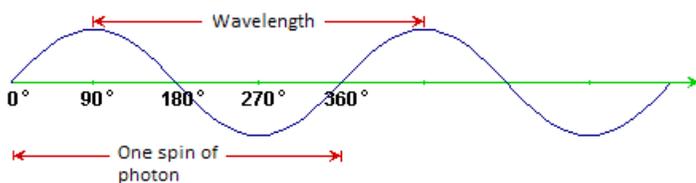
**Fig.3.** A photon moves up and down in  $x - z$  plane continuously due to the angular momentum of spinning photon with its eccentrically located nucleus while the photon is travelling in  $x -$  direction



While the photon is continuously moving forward in  $x -$  direction, the photon moves up in  $z -$  direction due to its angular momentum during first one fourth spin ( $0^\circ$  to  $90^\circ$  rotation), the photon moves down in  $z -$  direction due to its angular momentum during second one fourth spin ( $90^\circ$  to  $180^\circ$  rotation), the photon moves down in  $z -$  direction due to its angular momentum during third one fourth spin ( $180^\circ$  to  $270^\circ$  rotation) and the photon moves up in  $z -$  direction due to its angular momentum during last one fourth spin ( $270^\circ$  to  $360^\circ$  rotation).

Thus a photon travels in the form of a sinusoidal wave. One wave cycle is completed in one rotation or spin of the photon. The linear distance travelled in  $x -$  direction during one spin of photon is the wavelength of EM Radiation. The number of rotation or spin of photon in one second is the frequency of the EM Radiation. The wave of a photon is sinusoidal and shown in Figure 4.

**Fig.4.** The sinusoidal wave path of a single photon.



#### 4. Relationship of Spinning Speed with Frequency, Wavelength & Energy of Photon

The frequency, wavelength and energy depend on the angular velocity of spinning photon. When the spinning speed or angular velocity is high the photon completes one round quickly therefore the frequency is high. With higher spinning speed the angular momentum is also high resulting in higher energy of the photon.

The spinning speed is directly proportional to the frequency since the frequency is inversely proportional to the wavelength, the spinning speed is inversely proportional to the wavelength.

Angular velocity	$\omega = 2 \pi f$
Frequency	$f = \omega / 2 \pi$
Wavelength	$\lambda = c / f$
Moment of Inertia of Nucleus	$I_N = m r^2$

Moment of Inertia of Photon without Nucleus  $I_p = 2MR^2/5$   
 (Since mass of photon is concentrated at nucleus only, moment of Inertia of rest of photon without nucleus is assumed to be negligible in comparison to the moment of Inertia of nucleus.)

Kinetic Energy of Rotation	$KE_{Rot} = 2 I_N \omega^2$ $= 2 m r^2 (2 \pi f)^2$ $= 8 m r^2 \pi^2 f^2$
Linear Kinetic Energy	$KE_{Lin} = \frac{1}{2} m c^2$
Total Kinetic Energy	$KE = KE_{Rot} + KE_{Lin}$ $= 8 m r^2 \pi^2 f^2 + \frac{1}{2} m c^2$

The total energy of photon is mainly the kinetic energy due to high frequency & high velocity, assuming other forms of energies to be negligible, the total energy can be written as under:

Energy  $E = a_1 f^2 + a_2$

Where  $a_1 = 8 m r^2 \pi^2$  and  $a_2 = \frac{1}{2} m c^2$  are constants and

- $f$  : frequency
- $\omega$  : angular velocity
- $\lambda$  : wavelength
- $c$  : velocity of photon
- $m$  : mass of nucleus of photon
- $r$  : distance of nucleus from centre of photon
- $M$  : mass of photon without nucleus
- $R$  : radius of photon

#### 5. Formation of Waves of Electric Charge and Magnetic Field

According to New Quantum Theory the photon has electric charge which is located in the nucleus. This nucleus is not in the centre of photon and the spinning photon forms sinusoidal wave as shown in Figure 3. Therefore the electric charge of the nucleus also forms a sinusoidal electric charge field. This electric charge of photon is continuously moving and therefore generating magnetic field in the direction perpendicular to the electric charge field and also to the direction of travel. This is explained in detail below:

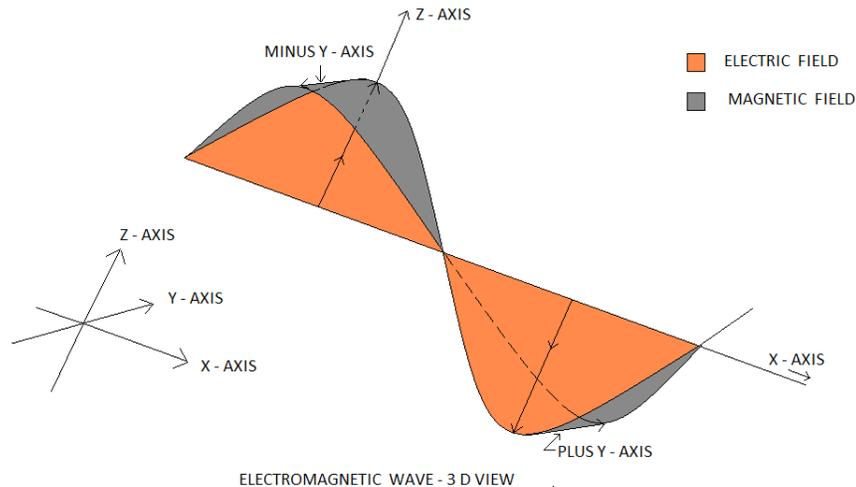
The nucleus of photon is rotating in  $x - z$  plane with the spin of the photon and making sinusoidal wave. Since the charge is located in the nucleus, the electric field is also making sinusoidal wave in  $x - z$  plane. The nucleus makes circle around the centre of spinning photon.

During first half cycle ( $180^\circ$ ) of sinusoidal wave formed in positions A – B – C – D - E of Figure 2 & 3, the nucleus and its charge are moving forward in  $x$  direction with respect to the centre of photon. According to Fleming's right hand rule the direction of magnetic field generated is perpendicular to the direction of electric charge movement and in (minus)  $y -$  direction in  $x - y$  plane.

Similarly during second half cycle ( $180^\circ$ ) of sinusoidal wave formed in positions E – F – G – H - A of Figure 2 & 3, the nucleus with charge is moving backward in x direction with respect to the centre of photon. The direction of magnetic field generated is perpendicular to the direction of electric charge and in (plus) y – direction in x – y plane. The magnetic field shifts from one side of photon (minus) y direction during first half cycle to the other side (plus) y direction during the second half cycle of photon.

The magnetic field (in x – y plane) is always perpendicular to the electric charge (x – z plane) and both are perpendicular to the direction of travel of photon (x - direction). With the spin of photon both these electric and magnetic fields form sinusoidal waves which are shown together in 3 D view in Figure 5.

**Fig.5.** 3D view of electromagnetic wave. Red sinusoidal wave in x – z plane is indicating electric field in  $\pm z$  direction and dark gray sinusoidal wave in x – y plane is indicating magnetic field with changing direction in  $\pm y$  direction. Both these fields are perpendicular to each other and also to the direction of travel x - direction.



## 6. Explanation of phenomena of EM Radiations by New Quantum Theory

### 6.1 Refraction

Refraction is the bending of EM Radiations due to the change of medium. The bending of ray is a surface phenomenon and takes place at the boundary only. The angle of bending depends on the ratio of velocities of EM Radiations in both the mediums or the ratio of refractive indexes.

The New Quantum Theory explains the phenomenon of refraction as under:

When the spinning photon of an EM radiation strikes the surface of different medium the spinning photon undergo following effects:

- At the boundary of new medium there is change of refractive index/velocity, this sudden change at the boundary results in momentary change in angular inertia of the spinning photon compelling the photon to turn or bend at the boundary (For

example: a ball with spin turns on touching the ground). This momentary change in angular inertia depends on the ratio of refractive indexes of the mediums. On again changing the medium from new medium to the old one, the spinning photon again turns at the boundary due to reverse momentary change in angular inertia and the direction of EM Radiation becomes parallel to the original direction in old medium.

- Depending on the refractive index of the new medium, the velocity of EM Radiation changes. If the velocity is lowered in the new medium, due to the higher refractive index, the wavelength of the EM Radiation reduces and the velocity is lowered. Same is true vice versa, the wavelength increases in the lower refractive index medium increasing the velocity of EM Radiation.

*The spin phenomenon of photon causes the refractive bending. Higher the spinning speed or frequency of the photon higher is the momentary change in angular inertia or the change in angle or bending of EM Radiations at the boundary.*

### 6.2 Dispersion of Light / EM Radiations

When a ray of white light passes through a triangular prism, the different colours are separated to display the phenomenon of dispersion. The New Quantum Theory explains the dispersion phenomenon similar to the refraction as under:

- White light is a mixture of different colours of different frequencies due to different spinning speed of the photons.
- When the medium changes, the spinning photons turn at the boundary of the new medium. Since high frequencies have higher spinning speed & higher energy the bending angle or momentary change in angular inertia of its photons is more. Similarly lower frequencies having lower spinning speed & lower energy the bending angle or momentary change in angular inertia of its photons is less.
- Photons of red colour with lower spinning speed have lower bending angle while the photons of violet colour with higher spinning speed have higher bending angle.
- For colours of different frequencies (different spinning speed) the bending angles of photons at the boundary are different. Therefore photons of all colours bend at different angles at the boundary of new medium resulting in separation of colours from the white light displaying the phenomenon of dispersion.

### 6.3 Absorption of EM Radiations / Colour of object

An object consists of molecules having atoms with dense nucleus surrounded by the rotating electrons. The object has particular arrangement of nucleus and electrons and on exposure to the EM Radiations the different types of photons behave as under:

Photons of several frequencies after colliding with the rotating electrons of the atoms in the object are scattered within the object and are absorbed. This is the absorption phenomenon generating equivalent energy.

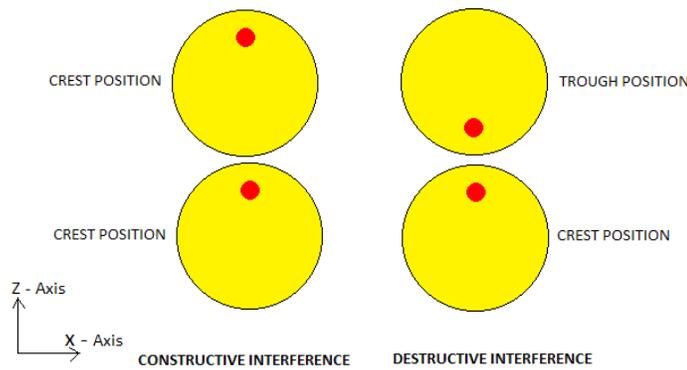
The photons of one or more frequency/frequencies after collision with rotating electrons of the object are reflected out from the object. Depending on the frequency/frequencies of the reflected photons the object displays the colour of reflected frequency or the mix of colours of different reflected frequencies. For example the different flowers appear to have different colours and shades depending on the reflected photons and absorbing the other photons.

**7. Interference**

EM Radiations exhibit the phenomenon of constructive and destructive interference like all other waves. When two spinning photons coincide at the crest position of the EM Radiations, the angular momentums of both photons are in same direction therefore the resultant is constructive and ultimate crest height is doubled. Similarly two spinning photons coinciding at the trough position also double the trough depth.

In destructive interference one spinning photon at its crest position coincide with other spinning photon at its trough position; the angular momentums of both photons are in opposite directions as a result the wave height is nullified. The photons of constructive and destructive interference are shown in Figure 6.

**Fig.6.** In Constructive Interference the angular momentums of both the photons are in same direction and in Destructive Interference these are in opposite direction.



In constructive interference:

$$\begin{aligned} \text{Angular momentum of upper photon in direction } z &= I_N \times \omega \\ &= m r^2 \times 2 \pi f \\ &= 2 \pi m f r^2 \end{aligned}$$

$$\begin{aligned} \text{Angular momentum of lower photon in direction } z &= 2 \pi m f r^2 \\ \text{Total angular momentum} &= 2 \pi m f r^2 + 2 \pi m f r^2 \\ &= 4 \pi m f r^2 \end{aligned}$$

In destructive interference:

$$\begin{aligned} \text{Angular momentum of upper photon in direction } z &= -2 \pi m f r^2 \\ \text{Angular momentum of lower photon in direction } z &= 2 \pi m f r^2 \\ \text{Total angular momentum} &= -2 \pi m f r^2 + 2 \pi m f r^2 = 0 \end{aligned}$$

The waves of EM Radiations display the interference phenomena by the constructive & destructive interference of angular momentums of the spinning photons.

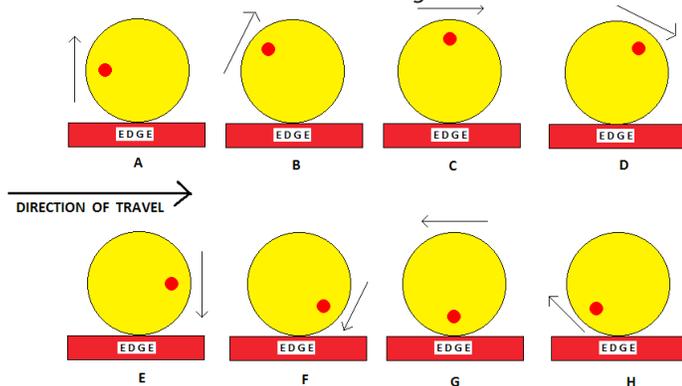
**8. Diffraction**

Diffraction phenomenon is the bending of waves around an obstacle. The spinning photon with eccentric nucleus of New Quantum Theory explains this phenomenon as under:

- A photon of EM Radiations strikes at the edge of an obstacle and is scattered in different direction depending on its resultant direction of angular momentum and linear momentum of the spinning photon.
- The photons with varying directions of resultant momentum strike the edge of the obstacle. These millions & millions of photons from the edge are scattered in different directions with constructive and destructive interference.
- When EM Radiations pass through a small width slit, due to the scattering of photons at the edges constructive and destructive interference take place. Simultaneously photons also pass through the slit without touching the edges of the slit and form bright band in the centre along with some of the photons scattered by the edges also to the central bright band. The remaining scattered photons form dark and bright bands on both sides of the central bright band by destructive & constructive interference.
- When EM Radiations face a circular obstacle, the scattering of spinning photons in different directions also take place at the edges. Some of the photons are scattered in the direction away from the circular object. These photons along with the photons coming directly from the source of EM Radiation around the periphery of the object form a brighter annular ring around the circular object displaying the phenomenon of diffraction.

The different positions of spinning photons at 45° with directions of angular momentum striking the edge of the slit or object are shown in Figure 7. The different combined angular and linear momentums with the reflection from the edge results in scattering of spinning photons in different directions.

**Fig.7.** Due to the spin of photon having eccentric nucleus, the resultant direction of movement of photon is continuously changing. Arrow near photon shows the direction of angular momentum. The photons are scattered in different directions depending on the resultant direction of the angular momentum and linear momentum after reflection from the edge



### Medium required for travel of EM Radiations as Wave

A wave requires medium to travel, waves cannot travel in vacuum. EM Radiations can travel in vacuum and also through the medium. According to New Quantum Theory the EM Radiations are spinning photon particles with eccentric nucleus having angular momentum and travelling in the path of sinusoidal waves. These waves are not continuous waves but only the photons move in the path of sinusoidal waves.

These pseudo waves of EM Radiations do not require any medium to travel and can travel in vacuum also.

### 9. Experiment

For the experiment a table tennis ball, a weight approx. 0.5 gram and glue are required. The weight is fixed on the ball with the glue. Now the ball has an eccentric weight.

The ball is rotated and simultaneously pushed to move on glass top table. The ball moves on glass table making a sinusoidal curve due to its eccentric weight.

This simple experiment proves the concept of eccentric nucleus with mass in the photon.

### 10. Conclusion

The spectrum of all EM Radiations including light consists of photon particles and each photon particle can travel in the form of sinusoidal wave due to its eccentric nucleus and spin. The spinning speed of the photon decides the frequency and energy of the EM Radiations. New Quantum Theory concludes as under:

- EM Radiations are spinning photon particles having an eccentric nucleus of charge and mass.
- EM Radiations move in the form of sinusoidal wave due to the angular momentum of spinning photons having eccentric nucleus.
- EM Radiations exhibit all the phenomena both of particle nature as well as wave nature since EM Radiations are particles and each particle is capable to move in the path of a sinusoidal wave.

- EM Radiations being particles do not require any medium to travel unlike other waves requiring a medium to travel.
- The frequency of EM Radiations is directly proportional to its spinning speed.
- The energy of EM Radiations depends on spinning speed. With increase in spin the angular momentum increases resulting in increasing the energy of photons of EM Radiations.
- Both electrical and magnetic fields move as sinusoidal wave perpendicular to each other and also to the direction of the travel of the EM Radiations. The directions of electrical field as well as magnetic field reverse after every half revolution of the photon or travel by half wavelength.

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