Particle-Wave Theory of Light

Rajeev Kumar*

Abstract

Light generates interference pattern in 'Young's double-slit experiment' which is possible only if light is wave in nature. Moreover, in photoelectric effect we observe that when light with energy greater than threshold energy strikes a metal, it ejects electrons. Such behaviour of light is possible only if light is particle in nature. In this paper a particle-wave theory of light has been presented in order to explain the dual nature of light.
Keywords : 'Young's double-slit experiment', Photoelectric effect, Dual nature of light.

1 PARTICLE-WAVE THEORY OF LIGHT

Let's consider a monochromatic source of light which is steady with respect to an inertial frame of reference.
Let's define a parameter 'q' termed as 'quality of a photon' as

$$q = E_0 \cos\left(\frac{2\pi s}{\lambda} - 2\pi \nu t + \phi\right)$$

where
E_0 = maximum energy of a photon in a ray of photons
ν = frequency of the ray of photons with respect to the source frame of reference
s = distance along the ray
λ = wavelength of the ray of photons
t = time elapsed
ϕ = initial phase

Let's define the energy of a photon as

$$E = |q| = \left|E_0 \cos\left(\frac{2\pi s}{\lambda} - 2\pi \nu t + \phi\right)\right|$$

If multiple photons merge together, then the quality of the resultant photon will be

$$q_{res} = \sum q_i$$

So the energy of the resultant photon will be

$$E = |q_{res}| = \left|\sum q_i\right|$$

It should be noted that this theory preserves the energy conservation law as no additional light energy gets created and the lost light energy gets converted into the heat energy upon the interference of photons.

*rajeevkumar620692@gmail.com

2 PROPOSITIONS ON PHOTON

- A photon has an extremely small mass and hence it will be influenced by the gravity.
- Velocity of a photon at emission will be the vector sum of the velocity of source at the instant of the photon emission and the velocity of photon from the same source at rest.
- Relative speed of approach and relative speed of separation of a photon with respect to the reflecting point of a reflecting surface will be equal along the normal and tangential directions of the reflecting surface at the point of reflection.

References

1. Hugh D. Young, Roger A. Freedman, Albert Lewis Ford, *“Sears’ and Zemansky’s University Physics with Modern Physics 13th edition.”*