New theory on the absorption and re-emission of photon by free electron

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Abstract: In this work, I have proposed new theory of the interaction of photon with free electron. According to this theory, unlike Thomson or Rayleigh scattering, photon does not scatter elastically but it absorbs and re-emits isotropically with same energy by free electron. It also proves that during interaction, mass and radius of electron are changing with respect to the energy of incident photon.

Keywords: Photon absorption-re emission; electron mass; photon-electron interaction; electron radius; photon mass.

1. INTRODUCTION:

Interaction of photons with bound or free electrons of an atom has been an interesting topic in the academic as well as research areas. Photon exhibits wave as well as particle nature according to wave- particle duality postulated by de Broglie. The effective mass of photon can be defined by the relation mphoton = [hv0 / (c2)] [1,2]. R. Manjunath [3] shown that photon carries mass proportional to its frequency and when photon interacts with the particle, mass of particle increases by an amount of the mass of photon. The elastic scattering of photon by free electron is discovered by J.J. Thomson [4]. A. H. Compton [4,5] described the inelastic scattering of photon by free orbital electron by process of billiard-ball collision between photon and free electron.

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The possibility of existence of the "big" electron having the certain size and the form when photon interacts with electron is proposed by J.J. Thomson [4] and Neoclassical theory [6]. However, the phenomenon of change in mass and size of electron during the interaction with photon by free electron is not clearly known. Here I have proposed new theory on absorption and re-emission of same energy photons by free electron which proves the existence of "big" electron during interaction.

2. NEW PROPOSED THEORY:

"When the photon of energy E and mass (mp) interact with the free electron of rest mass (me), electron will absorb all the energy of incident photon in terms of photon mass, becomes unstable and goes into excited state from its ground state. While de-exciting from excited state, electron emits photon of energy equivalent to its excess mass isotropically".

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In this process, excited electron becomes the new source of photon and emits the photon of same energy as that of incident photon. Therefore the energy of photon before and after the interaction is remains same.

Consider photons of energy E and mass mp incidents on free electron of rest mass me, Since the energy of photon is associated with its mass by Einstein mass-energy relation E=mp x c2, during the interaction of photon with electron, photon gives all its energy in terms of its mass mp, to the electron. Hence, the mass of electron increases by me + mp, becomes unstable and goes to the excited state with excitation energy equal to (me +mp) x c2 during time t1 which is shown in FIG.1.

From excited state, electron comes to its ground state by converting its excess mass in the form of electromagnetic radiation by process of E=Δm x c2 in time t2, where Δm = (mp + me - me). In later process, the change in mass is converted into the energy and energy of emitted photon is equal to the energy of incident photon.

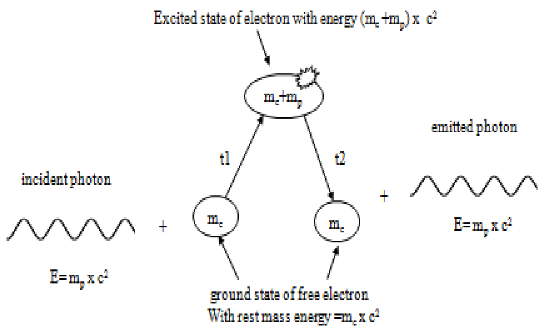

FIG.1. Excitation of electron from its ground state by interaction with incident photon.

Here the excited electron becomes new source of photon and emits photon in all direction. The time required to complete absorption and re-emission of photon in this process in t1+t2. Where, t1 is the time required to get electron into excited state and t2 is the time required to get electron into ground state from excited state.

Let us consider,

Incident photon mass = m_p
Incident photon energy = $m_p \times c^2$
Rest mass of electron = me
Rest mass energy of electron = me x c^2
Therefore,

According to conservation of mass and energy law,

$m_p + m_e = (m_p + m_e)^* = m_e + m_p$
$m_p + m_e = (\Delta m)^* = m_e + m_p$ ------ (1)
Where, $(\Delta m^*) = m_e + m_p$, is the increase in electron mass in excited state.
Multiplying both side of equation (1) by c^2 we get,
$m_p \times c^2 + m_e \times c^2 = (\Delta m \times c^2)^* = m_e \times c^2 + m_p \times c^2$ ----- (2)

$m_p \times c^2 + m_e \times c^2 = (\Delta E^*) = m_e \times c^2 + m_p \times c^2$

Here, $(\Delta m \times c^2)^* = (\Delta E^*)$ is the increase in rest mass energy of electron in excited state

Equation (2) shows energy is conserved in this process i.e. incident energy and final energy of photon remains same. Therefore there is no energy loss of photon during interaction.

According to the law of conservation of momentum,

Initial momentum of photon = $m_p \times c$
Final momentum of photon = $m_p \times c$
Initial momentum of electron: 0
Final momentum of electron: 0
$m_p \times c + 0 = 0 + m_p \times c$ ---- (3)

Equation (3) shows initial and final momentum is also conserved in this process.

3. ELECTRON RADIUS:

The classical electron radius is roughly the size the electron would need to have for its mass to be completely due to its electrostatic potential energy [7]. The classical electron radius, also known as the Thomson scattering length is given by following equation:

$$r_e = \left(\frac{1}{4\pi\varepsilon_0} \frac{e^2}{m_e c^2} \right) = 2.8179 \times 10^{-15} m \qquad \text{------} \quad (4)$$

Dirac suggests mathematic point like model of electron for quantum electrodynamics theory. Form the results of some experiments on the X and γ rays it is assumed that electron may be flexible ring or spherical shape distributed charge of electricity with radius of order [5] 2.42 x 10^{-12} m.

Equation (4) shows radius of electron (r_e) is inversely proportional to its mass. When photon interact with electron, the mass of electron increases by an amount of mass of photon (m_p), therefore there is decrease in radius of electron corresponding to mass of interacting photon and this change in radius of electron exists for the time interval of excitation and de-excitation of electron i.e. t1+t2.

4. CONCLUSION:

Present theory considered the incident photon carries mass equivalent to its energy. It proves the existence of electron with greater mass and smaller radius when interacted with photon. This increase in mass of electron could lead to the inelastic scattering of photon if two photons interact simultaneously with the same electron. This could also results in the inelastic scattering of photon by free electron in Compton scattering process. This theory can be useful for the study of fundamental properties of electron and other elementary particles in details. In the true sense, this is not the coherent or elastic scattering of photon by free electron; instead it is the absorption and re-emission of photon by the free electron.

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