Non-Scattering Photon Electron Interaction

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Abstract We propose a new model of the interaction between photons and electrons. During this interaction, the photon’s direction of movement does not change. The electron’s velocity along the photon’s direction of movement is close to c/2 in order to allow the interaction to proceed. During the photon and electron energy exchange process, when an electron’s speed is less than 0.7071c and greater than 0.5c, the photon will lose energy while the electron will gain energy; when an electron’s speed is more than 0.7071c, the photon will gain energy while the electron loses energy. Three physical experiments are proposed. In the first experiment, the electron speed is set to 0.6c and a red-shift is expected to occur. In the second experiment, the electron speed is set to 0.8c and a blue-shift is expected to occur. In the third experiment, the electron speed is set to 0.7071c or 0.4c. The theory predicts that there won’t be a photon wavelength change.

Keywords: Quantum, Campton Scattering, Relativity, red-shift, blue-shift


1. Introduction

A photon is an electromagnetic wave. This paper will explain a new interaction model in which the photon and electron can exchange energy and moving momentum during collision without changing the photon’s direction. The proposed model is different from Campton Scattering (e.g. [1]). In Campton Scattering, the initial electron momentum can be ignored. But in this case, the initial electron momentum is large and can’t be ignored. Also, its momentum change is relatively small. Therefore relativity effects (e.g. [2-10]) will be considered, but energy changes as a result of relativity effects will be ignored.

2. Interaction

Assume that M is the mass of an electron, m is the portion of a photon’s loss or gain of mass during the interaction; Vx is the electron’s initial speed perpendicular to the photon’s moving direction; Vy is the electron’s initial speed parallel to the photon moving direction; Vc is the change in Vy of the electron after the interaction. The electron kinetic energy before the interaction is:

\[ E_{\text{kin}} = M V_x^2 + M V_y^2 \]

The electron kinetic energy after the interaction is:

\[ E_{\text{kin}}' = (M V_x^2 + (V_y + V_c)^2) \]

m is the amount of a photon’s mass lost or gained during the interaction. Therefore the energy change is:

\[ \Delta E = mc^2 \]

The following energy conservation and momentum conservation equations can be deduced:

\[ M(V_x^2 + (V_y + V_c)^2 - (V_x^2 + V_y^2)) = mc^2 \]

\[ MV_c = mc \]

Combining the two equations,

\[ V_c = c - 2V_y \]

\[ m = M(c - 2V_y) / c \]

From formula (2),

\[ V_y = 0.5c(1 - m / M) \]
After the interaction, the new speed is greater than c/2:

\[ V_c + V_y = c - V_y \]

For the red-shifted visible light, the lost mass of m is less than the original mass of M. \( m/M < 5.55 \times 10^{-6} \), or:

\[ 0.5c(1 - 5.55 \times 10^{-6}) < V_y < 0.5c \]  

(4)

### 2.1. Impact Tube

The wavelength of an electron is \( 1.22 \times 10^{-12} \) m. It is much less than the ultraviolet light’s \( 10^{-9} \) m wavelength. A free electron can impact part of a photon. This is unlike the electron inside the atom, which has complex waves among which a photon may be able to find a longer wave to interact with.

Therefore, the electron limits its impact on the photon by its wavelength in circular form (Figure 2).

### 2.2. Crossing Speed

\( V_x \) in Figure 1 is called the crossing speed. It determines the angle of the impacted tube of the photon. Assume \( V_y = c/2 \). The wavelength of photon is \( \lambda \). Collision duration is t:

\[ \lambda + (1/2)ct = ct \]

\[ t = 2\lambda/c \]  

(5)

The time of the electron and photon interaction can be twice the photon’s period of \( \lambda/c \). When \( V_x > c/2 \), the electron can cross from one side of photon to the other. The total speed of the electron is:

\[ V = \sqrt{(c/2)^2 + (c/2)^2} = \frac{\sqrt{2}c}{2} = 0.7071c \]  

(6)

When the speed of electron is greater than 0.7071c, the electron starts to release energy to the photon, causing photon to blue-shift.

### 2.3. Blue-Shift

When \( V > 0.7071c \), the photon mass increment follows (2). In this case, the increased mass of m may have a larger unknown range.

### 3. Proposals for Experiments

#### 3.1. Red-Shift Case Formula

The electron has a charge of \( 1.6 \times 10^{-19} \) coulombs. 0.00016A of electron flow has \( 10^{15} \) electrons per second. At speed of \( c/2 \), the number of electrons per half meter is \( 3.3 \times 10^3 \).

Assume that a helium neon laser of 632.8 nm is used. The mass of a photon is:

\[ m_p = E/c^2 = \frac{hc}{(0.0000006328 \times c^2)} = 3.49276 \times 10^{-36} \text{ kg} \]

Rest mass of an electron:

\[ 319.10938215 \times 10^{-31} \text{ kg} \]

When travelling at \( c/2 \), the mass of an electron is:

\[ 10.51860 \times 10^{-31} \text{ kg} \]

From formula (3),

\[ V_y = (1/2)c \times \left(1 - 3.3205565 \times 10^{-6}\right) \text{ m/s} \]

The estimated maximum lost mass per collision, assuming that impact tube cross section radius is the electron wavelength, is:

\[ f = \left(3.3205565 \times 10^{-6}\right)^2 = 1.1 \times 10^{-11} \]

In other words, if 127749.7212425v is used, the gained voltage of the electron is 1.405\( \mu \)V. Fine voltage adjustment is critical to the success of the tests.

For 0.0016 A of electron flow in the ideal confined space in one micron diameter, the energy change factor is:

\[ 1.1 \times 10^{-11} \times 3.3 \times 10^4 \times 0.1 = 3.63 \times 10^{-8} \]

If the electron pulses for 10 ns in one second intervals, the same power can generate \( 10^8 \) times of the original intensity. Energy change factor becomes:

3.66

#### 3.2. Red-Shift Experiment Proposal
This experiment involves a confined electron and laser beam in a one meter long and one micro meter diameter tunnel. Both the electron and laser beam will pulse for 10ns in 1 second intervals. The electron emitter’s power is 204.4 W.

![Figure 3. Experiment Proposal](image)

Use 127749.7212425v to make the electron travel at speed of 0.6c while the angle of the photon off the tube’s wall is near 33.557309763821°.

Be careful to make fine adjustments of the electron’s voltage and try to record any red-shifting of the laser beam.

### 3.3. Blue-Shift Experiment Proposal

Use the same device as above. The speed of electron is 0.8c (148.69783883654v) and angle of photon is near 51.317812547°.

### 3.4. No Wavelength Change Experiment Proposal

When the electron’s speed is 0.4c or 0.7071c, there will be no photon wavelength change detected.

The following results are predicted for each successful energy exchange instance:

<table>
<thead>
<tr>
<th>Electron Speed (in unit of c)</th>
<th>Relative wavelength shift factor (positive is red-shift, in unit of 1*10^-11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>0.7071</td>
<td>-1</td>
</tr>
</tbody>
</table>

![Figure 4. Predicted Experimental Results](image)

### 4. Feasibility of the Experiments

The electron microscope (e.g. [12-34]) uses a focused beam of high-energy electrons to produce a variety of signals at the surface of a solid specimen. The diameter of the focused electron beam can be less than one nanometer.

### 4.1. Overall Design

Some small modifications to existing electron microscopes can be used to create the following design of the equipment of the experiment:

### References


