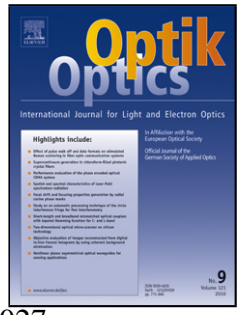

Title: On Compton scattering in dielectric medium

Author: A.I. Arbab

PII: S0030-4026(16)30649-0
DOI: http://dx.doi.org/doi:10.1016/j.ijleo.2016.06.027
Reference: IJLEO 57813

To appear in:

Received date: 14-4-2016
Accepted date: 6-6-2016

Please cite this article as: A.I. Arbab, On Compton scattering in dielectric medium, *<![CDATA[Optik - International Journal for Light and Electron Optics]]>* (2016), http://dx.doi.org/10.1016/j.ijleo.2016.06.027

On Compton scattering in dielectric medium

A. I. Arbab [(a)]

Department of Physics, College of Science, Qassim University, P.O. Box 6644, 51452 Buraidah, KSA

PACS 41.20.Jb – Electromagnetic wave propagation
PACS 78.20.Ci – Refractive index
PACS 42.25.Bs – Wave propagation

Abstract. - The Compton scattering in a dielectric medium is adopted. We have found that the momentum and energy of the photon inside the medium are related by the formula $E' = ncp'$, where n is the refractive index of the medium. This formula is shown to stem from the invariance of the Einstein relativity relation, $p = v\frac{E}{c^2}$ inside and outside the medium. The Minkowski and Abraham models of refractive index $p' = nE/c$ and $p' = E/(nc)$, respectively, require that $E' = E$ and $E' = n^2E$, respectively. The former model treated the photon as a wave (massless) and the latter treated the photon as a particle (matter) with an effective mass. The Snell's law is obtained by further imposing that the horizontal component of the light momentum remains the same.

Introduction. – Planck's formula states that energy is transported by photons that represents a quanta of energy. The photon is considered to be massless. The energy carried by a single photon is given by $E = hf$, where h is the Planck's constant and f is the frequency of light. However, de Broglie hypothesis states that particles as well do have wave nature (behavior). Einstein expounded his theory relating energy to mass (m) that is culminated in his famous equation, $E = mc^2$, where c speed of light in vacuum. It thus becomes appealing to infer that matter and wave behaviour are complementary to each other. This dictates that microscopic objects have a dual behavior depending on which circumstances the object is confronting.

In the photoelectric and Compton effects, the photon exhibits a particle-like behavior in which it collides with the electron. During this collision the energy and momentum are conserved. Despite this fact no mass is associated to photons partaking in these two phenomena. In quantum electrodynamics, the photon is taken to be massless in order to preserve the gauge transformation. There is no physical reason, apart from mathematical conveniences, dictating that the photon is massless. Some recent theories allowing the photon to be massive are available.

However, the Snell's law governing the refraction of light by a medium stipulates that light is a wave that propagates in a medium in such a way it extremizes its time span between any two points. In Compton effect, the wavelength of the incident light is found to change by a factor

[(a)]arbab.ibrahim@gmail.com