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Compton Effect Symmetry *)

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Abstract. $2\lambda_C$ constant is relevant for Compton effect description and its symmetry.
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In the case of an experiment with hard X rays scattered by a solid material under big angles, Compton [1-2] found that the wave length of the scattered radiation contains beside the wave length of the incident radiation λ, a second component with a wave length λ', their difference $\Delta\lambda = \lambda - \lambda'$, depending of the scattering angle φ, according to the relations:

$$\Delta\lambda = \frac{h}{m_e c}(1-\cos\varphi)\ , \tag{1}$$

$$\Delta\lambda = 2\frac{h}{m_e c}\sin^2\frac{\varphi}{2}\ . \tag{2}$$

where the constant group h, m_e , c, under the form,

$$\lambda_C = \frac{h}{m_e c} = 2.4263102389(16)\times 10^{-10}\ cm\ , \tag{3}$$

represents a new fundamental constant, having the dimension of a length, named the Compton wavelength of the electron (λ_C).

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To illustrate the scattering kinematics, in which a photon having the impulse $h\nu/c$ ran into an electron initially in repose, resulting the photon with the impulse $h\nu'/c$ and the recoil electron with the impulse $m_e v$, Compton used a vectorial diagram (Fig.1a).

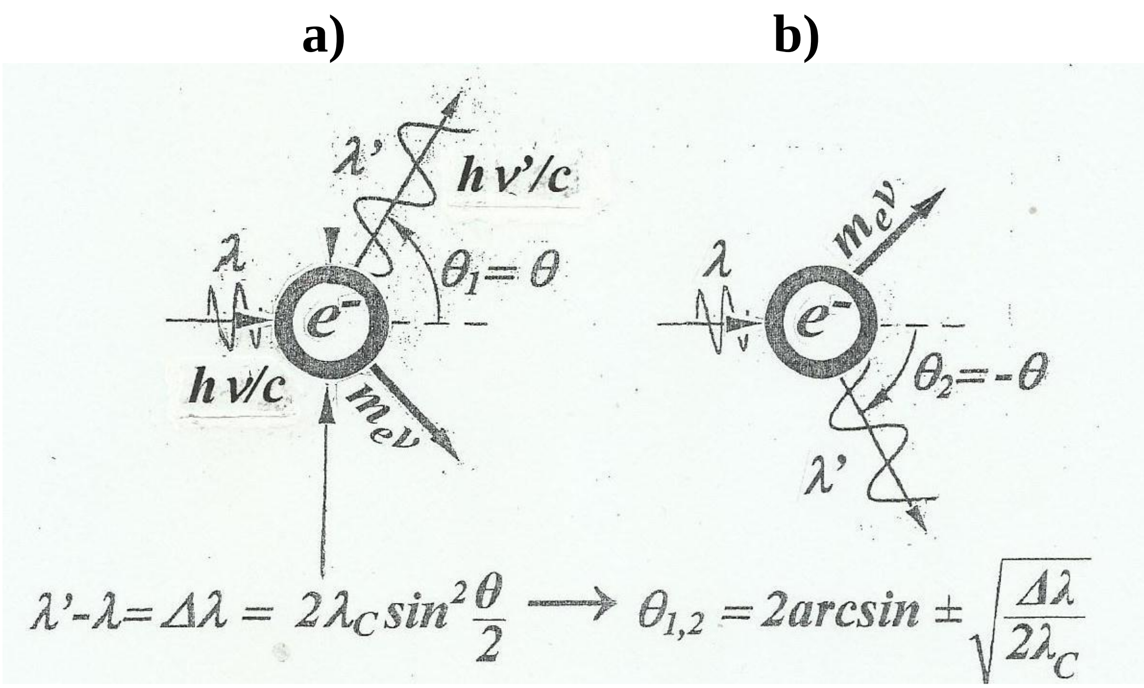

Fig.1 The Compton effect kinematics. Emphasizing the symmetry of the impulse diagram to the incident radiation axis

Applying the energy and impulse conservation laws, Compton deducted the previous relations.

Analyzing the relations (1-2) it results that they are different through the consequences which results from the way the angle φ intervene, according to the trigonometric equality $2\sin^2\varphi/2 = 1-\cos\varphi$.

From the mathematical perspective both expressions are correct. But the phenomena has to be analyzed from the physical implications as well. A variation of the φ angle in the maximum possible interval $[0, \pi]$, (corresponding to a running into an electron in which this one is imperceptible deviated for $\varphi = 0$, and to a frontal running into an electron in which the incident radiation changes its moving sense for $\varphi = \pi$), leads to a variation of the difference $\Delta\lambda$ between the limits $0 < \Delta\lambda < 2\lambda_C$.

We note that any value between the two limits is not significant, excepting the middle of the field $(\varphi = \pi/2)$, for which we have $\lambda_C = h/m_e c$, the fundamental physical constants being grouped by the simplest mode, without parasite coefficients.

Obviously, the maximum limit $2\lambda_C = 4.8526204778(32)\times 10^{-10} cm$, presents a distinct interest from the physical point of view.

A clarification of these two situations in which the Compton wave length λ_C or its double $2\lambda_C$ intervene is related to the solution of the inverse problem, which imply the phenomena symmetry, meaning that by making a Compton scattering experiment and measuring $\Delta\lambda$ to determine the scattering angle φ. It is observed that only the relation $\Delta\lambda = 2\lambda_C \sin^2\varphi/2$ offer the symmetrical solutions to the incident radiation trajectory,

$$\varphi = 2 arc \sin + \sqrt{\frac{\Delta\lambda}{2\lambda_C}}, \tag{4}$$

$$\varphi' = 2 arc \sin - \sqrt{\frac{\Delta\lambda}{2\lambda_C}} = -\varphi. \tag{5}$$

In other words, the diagram a) has to be completed with another diagram b) symmetrical by the incident radiation axis. It also results that only the constant $2\lambda_C$ intervene in the experiment. This constant needs to be included in the table of fundamental physical constants [3-5].

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