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THE SYMMETRY OF THE COMPTON EFFECT AND THE $2\lambda_C$ CONSTANT

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Abstract
According to this article, for Compton effect description and its symmetry it is relevant $2\lambda_C$ constant.
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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 wavelength of the scattered radiation contain beside the wavelength 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,

$$\lambda_C = \frac{h}{m_e c} = 2.4263102175(33)\times 10^{-10}\ cm\,, \tag{3}$$

represent a new fundamental physical constant, having the dimension of a length, named the Compton wavelength of the electron (λ_C), [3].

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).

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

Analysing 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 $2\sin^2\varphi/2 = 1-\cos\varphi$.

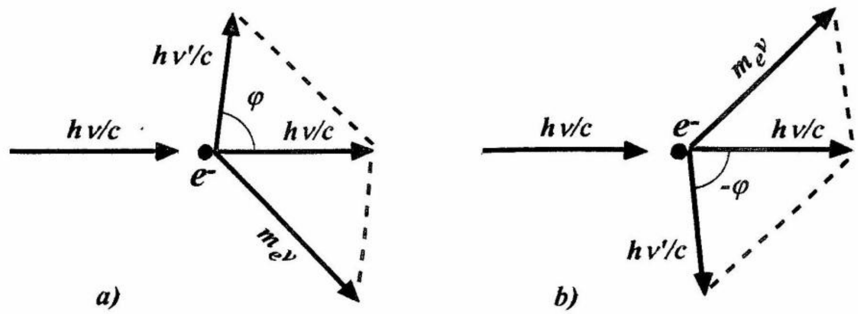

Fig.1 The Compton effect kinematics. Emphasising the symmetry of the impulse diagram to the incident radiation axis

From the mathematical perspective both expressions are corect. But the phenomena has to be analysed from the physical implications too. A variation of the φ angle in the maximum possible interval [0, π], (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 $2\lambda_C = 4.8526204350(67)\times 10^{-10} cm$, presents a distinct interest from the physical poin of view.

A clarification of these two situations in which the Compton wavelength 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. Consequence: in tables of fundamental physical constants must to be mentioned the $2\lambda_C$ value.

λ_C and $2\lambda_C$ are linked with the notion of extended quantum electron (charge) [4]. These appears as a ratio radius/diameter, only the diameter being relevant.

The fact that the effect does not depend on the electron position in the atom confirms this interpretation in another way.

REFERENCES

[1]. A.H.Compton, The Spectrum of the Scattered X-rays, Physical Review 21, 409 (1923).

[2]. A.H.Compton, A Quantum Theory of the Scattering X-rays by Light Elements, Physical Review 21, 483 (1923).

[3]. P.J. Mohr, B.N. Taylor, D.B. Newell, Recommended Values of the Fundamental Physical Constants – 2006, CODATA.

[4]. A.H.Compton, The Size and Shape of the Electron, Phys. Rev. **14**, 20 (1919).

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