164(4): The Concept of $\omega_1 = R_1^{1/2} c$

We propose the equation:

$$\hbar \omega_1 = m_1 c^2, \quad -(1)$$

$$\omega_1 = R_1^{1/2} c. \quad -(2)$$

In these equations ω_1 replaces the rest frequency ω_0 of de Broglie and m_1 is the traditional concept of constant mass.

In note 164(3) it was found that:

$$A = \omega\omega' - \omega_0(\omega - \omega') = x_1^2 + (\omega^2 - x_1^2)^{1/2}(\omega'^2 - x_1^2)^{1/2}\cos\theta \quad -(3)$$

where

$$x_1 = \frac{m_1 c^2}{\hbar} = \omega_1 \quad -(4)$$

Assume now that the photon mass m_1 is a constant in keeping with the usual concept of mass in physics. This must mean that there is a varying frequency ω_1 defined in ECE theory by eq. (2).

This concept may be easier to accept than one of varying mass m_1. However, both concepts are equivalent through eq. (4). Therefore the functions x_1 and x_2 that appear in the

2)

, scattering equation (3) are defined by:

$$x_1 = \omega_1 = R_1^{1/2} c \quad -(5)$$

$$x_0 = \omega_0 = R_0^{1/2} c \quad -(6)$$

The three fundamental equations are:

$$E = \gamma m c^2 \quad -(7)$$

$$\underline{p} = \gamma m \underline{v} \quad -(8)$$

$$R = \left(\frac{mc}{\hbar}\right)^2 \quad -(9)$$

so

$$\boxed{\omega = \gamma R^{1/2} c \,, \quad \underline{\kappa} = \gamma R^{1/2} \frac{\underline{v}}{c}} \quad -(10)$$

Eq. (10) must now be used in scattering theory. The energy and momentum conservation equations of note 164(3) are:

$$\omega + \omega_0 = \omega' + \omega'' \quad -(11)$$

and

$$\underline{\kappa} = \underline{\kappa}' + \underline{\kappa}'' \quad -(12)$$

[th]ese lead to:

$$= \omega\omega' - c R_2^{1/2}(\omega - \omega') = R_1 c^2 + (\omega^2 - R_1 c^2)^{1/2} (\omega'^2 - R_1 c^2)^{1/2} \cos\theta \quad -(13)$$

$$\rightarrow \omega\omega' \cos\theta \quad -(14)$$

as

$$R_1 \rightarrow 0 \quad -(15)$$

Therefore for a "massless particle" R_1 is zero.

More precisely, a massless particle is one defined by

$$\omega = \gamma R^{1/2} c \quad -(16)$$

with

$$\gamma \to \infty, \; R \to 0, \; v \to c \quad -(17)$$

so the quantity:

$$\kappa := \gamma R^{1/2} \quad -(18)$$

is <u>indeterminate</u>.

In this limit the Compton effect is given by:

$$\boxed{c R_2^{1/2} (\omega - \omega') = \omega\omega' (1 - \cos\theta)} \quad -(19)$$

where

$$R_2 = (m_2 c / \hbar)^2 \quad -(20)$$

and where m_2 is the electron mass.

<u>Experimentally</u> in the Compton effect it is found that:

$$A = \omega\omega' \cos\theta \quad -(21)$$

From eq. (4) of note 164(3) this means:

$$R_1 c^2 = \frac{1}{2a} \left(-b \pm (b^2 - 4ac')^{1/2} \right) \quad -(22)$$

with

$$c' = 0 \quad -(23)$$

4) A possible solution is:

$$R_1 = 0 = \frac{1}{2a}\left(-b + b\right) \quad -(24)$$

but it is possible that:

$$\boxed{R_1 = -\frac{b}{a}} \quad -(25)$$

where

$$b = \left(\omega^2 + \omega'^2\right)\cos^2\theta - 2\omega\omega'\cos\theta$$

$$a = 1 - \cos^2\theta$$

This means that the curvature R_1 associated with the Compton effect experiment is non-zero experimentally.

Conclusion

The new concept of R_1 in scattering theory replaces the concept of massless photon, and in general replaces the concept of particle mass

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