243(2): Compton Scattering from a Solid of 3N Vibrators

As in UFT160 and note 160(3) consider the relativistic scattering of a mass m_1 from a stationary mass m_2. The equation of energy conservation is:

$$\gamma m_1 c^2 + m_2 c^2 = \gamma' m_1 c^2 + \gamma'' m_2 c^2 \quad -(1)$$

where:

$$\hbar\omega = \gamma m_1 c^2, \; \hbar\omega' = \gamma' m_1 c^2, \; \hbar\omega'' = \gamma'' m_2 c^2 \quad -(2)$$

i.e.

$$x_2 = \frac{m_2 c^2}{\hbar} = \omega' + \omega'' - \omega. \quad -(3)$$

The Lorentz factors are:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2}, \; \gamma' = \left(1 - \frac{v'^2}{c^2}\right)^{-1/2}, \quad -(4)$$

$$\gamma'' = \left(1 - \frac{v''^2}{c^2}\right)^{-1/2}$$

The equation of momentum conservation is:

$$\underline{p} = \underline{p}' + \underline{p}'' \quad -(5)$$

so

$$p''^2 = p^2 + p'^2 - 2pp'\cos\theta. \quad -(6)$$

Now use:

$$\underline{p} = \hbar \underline{\kappa}, \; \underline{p}' = \hbar \underline{\kappa}', \; \underline{p}'' = \hbar \underline{\kappa}'' \quad -(7)$$

2)

So
$$\kappa''^2 = \kappa^2 + \kappa'^2 - 2\kappa\kappa'\cos\theta \quad -(8)$$

The de Broglie / Einstein equations assert that:

$$\hbar\kappa = \gamma m_1 v, \quad \hbar\omega = \gamma m_1 c^2$$
$$\hbar\kappa' = \gamma' m_1 v', \quad \hbar\omega' = \gamma' m_1 c^2 \quad -(9)$$
$$\hbar\kappa'' = \gamma'' m_2 v'', \quad \hbar\omega'' = \gamma'' m_2 c^2$$

so
$$\kappa = \frac{\omega v}{c^2}, \quad \kappa' = \frac{\omega' v'}{c^2}, \quad \kappa'' = \frac{\omega'' v''}{c^2} \quad -(10)$$

From eqns. (8) and (10):
$$\omega''^2 v''^2 = \omega^2 v^2 + \omega'^2 v'^2 - 2\omega\omega' v v' \cos\theta \quad -(11)$$

From eqns. (4) and (9):
$$\frac{v''^2}{c^2} = 1 - \left(\frac{x_2}{\omega''}\right)^2, \quad \frac{v'^2}{c^2} = 1 - \left(\frac{x_1}{\omega'}\right)^2, \quad \frac{v^2}{c^2} = 1 - \left(\frac{x_1}{\omega}\right)^2 \quad -(12)$$

where
$$x_1 = \frac{m_1 c^2}{\hbar} \quad -(13)$$

From eqns. (11) and (12):
$$\omega^2 + \omega'^2 - \omega''^2 = 2x_1^2 - x_2^2 + 2\left(\omega^2 - x_1^2\right)^{1/2}\left(\omega'^2 - x_1^2\right)^{1/2}\cos\theta \quad -(14)$$

From eqns. (3) and (14):

3)

$$x_2 = \frac{1}{\omega - \omega'}\left[\omega\omega' - \left(x_1^2 + \left(\omega^2 - x_1^2\right)^{1/2}\left(\omega'^2 - x_1^2\right)^{1/2}\cos\theta\right)\right] \quad -(15)$$

In standard Compton scattering theory it is assumed that:

$$m_1 = 0 \quad -(16)$$

so eq. (15) reduces to:

$$x_2 = \frac{\omega\omega'}{\omega - \omega'}\left(1 - \cos\theta\right) \quad -(17)$$

i.e.

$$\frac{1}{\omega'} - \frac{1}{\omega} = \frac{\hbar}{m_2 c^2}\left(1 - \cos\theta\right) \quad -(18)$$

Usually eq. (18) is expressed in terms of wavelength using:

$$\omega = 2\pi f, \quad f\lambda = c, \quad \omega = \frac{2\pi c}{\lambda} \quad -(19)$$

so

$$\lambda' - \lambda = \frac{h}{m_2 c}\left(1 - \cos\theta\right) \quad -(20)$$

where the Compton wavelength is

$$\lambda_0 = \frac{h}{m_2 c} \quad -(21)$$

The Compton angular frequency is:

4)

$$x_2 = \omega_0 = \frac{m_2 c^2}{\hbar} \quad -(22)$$

So:
$$\frac{1}{\omega'} - \frac{1}{\omega} = \frac{1}{\omega_0}\left(1 - \cos\theta\right) \quad -(23)$$

In a solid of 3N vibrators, the Einstein theory of specific heats assumes that each vibrator has the energy:

$$E_0 = \hbar\omega_0 \quad -(24)$$

The Boltzmann distribution is used to find the average energy at a temperature T:

$$\langle E_0 \rangle = E_0 \left(\frac{x}{1-x}\right) \quad -(25)$$

where
$$x = \exp\left(-\frac{\hbar\omega_0}{kT}\right) \quad -(26)$$

where k is the Boltzmann constant. So:

$$\langle \omega_0 \rangle = \omega_0 \left(\frac{x}{1-x}\right) \quad -(27)$$

$$-(28)$$

and:
$$\frac{1}{\omega'} - \frac{1}{\omega} = \left(\frac{1-x}{x}\right)\frac{1}{\omega_0}\left(1-\cos\theta\right)$$

i.e
$$\lambda' - \lambda = \left(\frac{x}{1-x}\right)\lambda_0\left(1-\cos\theta\right) \quad -(29)$$

6) The Compton effect for an Einstein solid is therefore:

$$\lambda' - \lambda = \left(\frac{1-x}{x}\right)\frac{h}{m_2 c}\left(1-\cos\theta\right) \quad -(30)$$

$$\boxed{\lambda' - \lambda = \left(e^{\hbar\omega_0/(kT)} - 1\right)\frac{h}{m_2 c}\left(1-\cos\theta\right)} \quad -(31)$$

Therefore the scattering of a photon from an Einstein solid should depend on temperature according to eq. (31).

Problems for the Standard Physics

1) The Compton effect formula (20) for the scattering of a photon from an electron works only if it is assumed that the mass of the photon is zero: this assumption contradicts the Einstein / de Broglie equation:

2)
$$\hbar\omega = \gamma m c^2 \quad -(32)$$

because: $\omega \neq 0, \; m = ?\, 0$ $\quad -(33)$

3) If eq. (32) is accepted the Compton formula becomes eq. (15) and from the

7) work of UFT 160 ff., particle physics collapses at the fundamental level

In order to propose a solution, the October Postulates and R theory were proposed, in which the masses m_1 and m_2 were allowed to become dependent on curvature. The use of quantum theory also electrodynamics and Higgs boson theory collapse because the fundamental eq. (1) leads to severe self inconsistency on a fundamental level.

Eq. (31) now provides a further test of particle scattering theory by testing the temperature dependence of Compton scattering from an Einstein solid. This type of theory will be further developed in notes for UFT 243.