1) 163(6): The Concept of Covariant Mass Ratio.

A new concept of physics is needed to begin to meet the challenge posed by UFT 158 to 162. This concept was first introduced in the third October postulate:

$$x = \frac{R}{R_0} = \left(\frac{m}{m_0}\right)^2 \quad -(1)$$

The ratio $x$ is named "the covariant mass ratio". This note is the first attempt to investigate the properties of $x$ by considering it within the context of general scattering theory. Consider the scattering of a particle with initial angular frequency $\omega$ colliding with a static particle of rest angular frequency $\omega_0$. In the usual theory of scattering:

$$\omega + \omega_0 = \omega' + \omega'' \quad -(2)$$

where $\omega'$ is the scattered angular frequency of $\omega$, and $\omega''$ the scattered angular frequency of $\omega_0$. Eq. (2) is the conservation of total energy. The conservation of momentum in the usual theory is:

$$\underline{p} = \underline{p}' + \underline{p}'' \quad -(3)$$

i.e.

$$\underline{\kappa} = \underline{\kappa}' + \underline{\kappa}''. \quad -(4)$$

so

$$\kappa''^2 = \kappa^2 + \kappa'^2 - 2\kappa\kappa'\cos\theta. \quad -(5)$$

The astonishing discovery was made in UFT 158 to UFT 162 that eqns (2) and (5) are completely self-inconsistent. This has major consequences throughout the physical sciences.

2) The self consistency emerges only on consideration of the complete de Broglie equations of 1922 – 1924. These are:

$$E = \hbar\omega = \gamma m c^2 \quad -(6)$$

$$\underline{p} = \hbar \underline{\kappa} = \gamma m \underline{v} \quad -(7)$$

where

$$p^\mu = \left(\frac{E}{c}, \underline{p}\right). \quad -(8)$$

Here $E$ is the total relativistic energy of Einstein, $\underline{p}$ is the relativistic momentum of Einstein. The factor $\gamma$ is defined by

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \quad -(9)$$

where $\underline{v}$ is the velocity of the particle.

From eqns (6) and (7):

$$\kappa = \omega v / c^2, \quad -(10)$$

$$-(11)$$

so eqn. (5) is:

$$\omega''^2 v''^2 = \omega^2 v^2 + \omega'^2 v'^2 - 2\omega\omega' v v' \cos\theta.$$

which using eq. (9) can be rewritten as:

$$\omega^2 + \omega'^2 - \omega''^2 = 2x_1^2 - x_2^2 + 2(\omega^2 - x_1^2)^{1/2}(\omega'^2 - x_1^2)^{1/2}\cos\theta$$

$$-(12)$$

where

$$x_1 = m_1 c^2 / \hbar, \quad x_2 = m_2 c^2 / \hbar. \quad -(13)$$

We have

$$x_2 = \omega_0, \quad -(14)$$

so

$$\omega_0 = \frac{\omega\omega'}{\omega - \omega'} - \left(\frac{x_1^2 + (\omega^2 - x_1^2)^{1/2}(\omega'^2 - x_1^2)^{1/2}\cos\theta}{\omega - \omega'}\right)$$

$$-(15)$$

3) In the limit:

$$x_1 \rightarrow 0 \quad -(16)$$

eq. (15) becomes:

$$\omega_0 = \frac{\omega\omega'(1-\cos\theta)}{\omega-\omega'} \quad -(17)$$

which is the usual Compton effect formula.

From the considerations in UFT 158 – 162 it is now known that these equations are severely self inconsistent. There is a property of nature that is missing from them. From ECE theory this was inferred to be $x$ of eq. (1), the covariant mass ratio.

The problem that must be addressed now is that of finding how $x$ enters into these equations, and then determining the properties of $x$. Denote:

$$y = x^{1/2} \quad -(18)$$

and as a first attempt make the hypothesis:

$$\boxed{\omega + \omega_0 = y\omega' + \omega''} \quad -(19)$$

so

$$y = \frac{1}{\omega'}\left(\omega + \omega_0 - \omega''\right) \quad -(20)$$

$$= \frac{m_1}{m_{10}},$$

i.e.

$$\boxed{m_1 = \frac{m_{10}}{\omega'}\left(\omega + \omega_0 - \omega''\right)} \quad -(21)$$

+) Eq. (21) means that the covariant mass is defined by eq. (21). From note 161(6):

$$R_1 = q^{\nu}_{a} \partial^{\mu} \left( \omega^{a}_{\mu\nu} - \Gamma^{a}_{\mu\nu} \right) \quad -(22)$$

$$R_0 = \left( \frac{m_{10} c}{\hbar} \right)^2 . \quad -(23)$$

Define:

$$R_1 = \left( \frac{m_1 c}{\hbar} \right)^2 , \quad -(24)$$

so

$$\boxed{m_1 = \frac{\hbar}{c} R^{1/2} = \frac{m_{10}}{\omega'} \left( \omega + \omega_0 - \omega'' \right)} \quad -(25)$$

The mass $m_0$ is that of the free particle, the mass $m$ is the mass after collision.

These concepts exist only in general relativity as corrected by ECE theory. For simplicity, it has been assumed that $m_2$ is unchanged by the collision. In general $m_2$ is also changed by the collision. In eq. (12):

$$\boxed{\omega' \rightarrow y \omega'} \quad -(26)$$

so:

$$\left( y^2 \omega'^2 - x_1^2 \right)^{1/2} \cos \theta = A y - B , \quad -(27)$$

$$A = \frac{\omega' ( \omega + \omega_0 )}{( \omega^2 - x_1^2 )^{1/2}} , \quad B = \frac{x_1^2 + \omega_0 \omega}{( \omega^2 - x_1^2 )^{1/2}} . \quad -(28)$$

Therefore the following quadratic is obtained for y:

$$(A^2 - \omega'^2 \cos^2\theta)\, y^2 - 2ABy + B^2 - x_1^2 \cos^2\theta = 0 \quad -(29)$$

i.e.

$$\boxed{y = \frac{m_1}{m_{10}} = \frac{1}{2a}\left(-b \pm \left(b^2 - 4ac'\right)^{1/2}\right)} \quad -(30)$$

where:

$$\left.\begin{aligned} a &= A^2 - \omega'^2 \cos^2\theta, \\ b &= -2AB, \\ c' &= B^2 - x_1^2 \cos^2\theta \end{aligned}\right\} \quad -(31)$$

Spectrum for $m_1/m_{10}$

In general $m_1/m_0$ depends on $\omega$, $\omega'$ and $\theta$, and also on:

$$\omega_0 = m_2 c^2/\hbar \quad -(32)$$

Here $m_2$ is the mass of the initially static target particle. The ratio $R_1/R_{10}$ is:

$$y^2 = \frac{R_1}{R_{10}} \quad -(33)$$

The covariant mass ratio means that a scattered particle aquires a memory of the collision process.