A NEW THEORY OF PARTICLE COLLISIONS AND LOW ENERGY NUCLEAR REACTIONS (LENR).

by

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ABSTRACT

Particle scattering and annihilation processes, and low energy nuclear reactions, are described using a theory of inelastic scattering on the classical relativistic level. The use of inelastic scattering theory ensures that energy is released. This may be the energy peaks observed in particle colliders or the energy released in low energy nuclear reactors (LENR). The theory is brought to the point where it can be developed in a relativistic quantum theory capable of incorporating quantum tunnelling theory.

Keywords: ECE theory, inelastic particle collision theory, low energy nuclear reactions, positron electron annihilation.

UFT 247

1. INTRODUCTION

In UFT158 to UFT170 of this series of two hundred and forty seven papers and several books to date {1 - 10}, it was shown that the relativistic theory of particle collisions collapses into nonsense as soon as it departs form the usual approach to Compton scattering (www.aias.us , www.atomicprecision.com, www.upitec.org, www.webarchive.org.uk, and Google Scholar)). We have returned to this theme in recent papers. The fundamental problem revealed by this work is that quantum mechanics cannot be consistent with special relativity in standard particle collision theory. The problem exists at a fundamental level, so exists at all levels, including quantum electrodynamics and quantum field theory. A remedy was attempted in the October Postulate of UFT161, and in the development of the concept of mass into the concept of curvature R in ECE theory. In Section 2 a remedy is found for this basic problem by treating particle collisions as inelastic processes in which energy is released. This may be the energy peaks observed in particle colliders or the energy released in low energy nuclear reactors (LENR). It is found that the only process that can be described with elastic collisions is Compton scattering regarded in the traditional way, a process in which a "massless" particle, the photon, is scattered from a massive electron. All other particle collision processes require a theory of inelastic scattering. These processes include positron electron annihilation, studied for thirty five years with particle accelerators. The theory is brought to the point at which it can be quantized into a relativistic quantum theory capable of producing quantum tunnelling. In UFT226 to UFT231 the LENR process was explained in terms of quantum tunnelling used to surmount the Coulomb barrier.

2. INELASTIC PARTICLE COLLISION THEORY.

In the simplest type of positron electron annihilation it is considered conventionally that two photons are given off, each with the rest energy of the positron and electron. The usual view of annihilation in standard physics is that the moving positron collides with the moving electron and in the course of the collision both particles are at rest simultaneously. The result in the usual view is that two photons move away in opposite directions, each with the rest energy of the electron, equal to the rest energy of the positron and therefore at gamma ray frequencies. Total energy, total linear momentum, total angular momentum and total charge must be conserved. This is not a point of view that has much merit in it for reasons developed in this section. The usual view of particle physics uses the idea of cross over symmetry. If there is a particle reaction such that:

$$A + B \rightarrow C + D \qquad - (1)$$

then cross over symmetry means that there exists the reaction:

$$A + \bar{C} \rightarrow \bar{B} + D \qquad - (2)$$

where the bar denotes antiparticle. For example, Compton scattering is denoted by:

$$\gamma + e^- = \gamma + e^- \qquad - (3)$$

where γ denotes the photon and e^- the electron. The photon is considered in standard physics to be its own anti particle, because the photon is not charged. Cross over symmetry therefore demands that there exists the positron electron annihilation:

$$e^+ + e^- = \gamma + \gamma \qquad - (4)$$

It is seen that Eq. (4) is generated from Eq. (3) by:

$$\gamma \rightarrow e^+ \quad (B \rightarrow \bar{C}) \qquad - (5)$$

$$e^- \rightarrow \gamma \quad (C \rightarrow \bar{B}) \qquad - (6)$$

The two processes are therefore described by the same equations of conservation of energy and momentum, respectively:

$$E_1 + mc^2 = E_2 + E_3 \quad -(7)$$

and

$$\underline{p_1} = \underline{p_2} + \underline{p_3}. \quad -(8)$$

In Compton scattering E_1 is the energy of the incoming photon, mc^2 is the rest energy of a static electron of mass m, E_2 is the energy of the scattered photon, and E_3 is the energy of the scattered electron. In Compton scattering $\underline{p_1}$ is the momentum of the incoming photon, and $\underline{p_2}$ and $\underline{p_3}$ are the momenta of the scattered photon and electron respectively. The energy of the incoming photon in the Compton effect is:

$$E_1 = \hbar\omega_1 = \gamma_1 m_1 c^2 \quad -(9)$$

where m_1 is the photon mass and γ_1 the relevant Lorentz factor. In the standard physics there is no photon mass and the photon travels at c in the vacuum, so:

$$E_1 = \hbar\omega_1. \quad -(10)$$

The energy of the scattered photon in standard physics is:

$$E_2 = \hbar\omega_2. \quad -(11)$$

The energy of the scattered electron is:

$$E_3 = \hbar\omega_3 = \gamma_3 mc^2 \quad -(12)$$

The relativistic momentum of the incoming photon is:

$$\underline{p}_1 = \hbar \underline{\kappa}_1 = \gamma_1 m_1 \underline{v}_1 \quad -(13)$$

and the relativistic momenta of the scattered photon and electron are respectively:

$$\underline{p}_2 = \hbar \underline{\kappa}_2 = \gamma_2 m_1 \underline{v}_2, \quad -(14)$$

$$\underline{p}_3 = \hbar \underline{\kappa}_3 = \gamma_3 m \underline{v}_3. \quad -(15)$$

In the standard physics there is no photon mass, so the quantized photon momenta are considered to be:

$$p_1 = \hbar \kappa_1 = \hbar \omega_1 / c \quad -(16)$$

$$p_2 = \hbar \kappa_2 = \hbar \omega_2 / c \quad -(17)$$

Therefore by cross over symmetry in the standard physics the same theory must apply to electron positron annihilation. If so, E_1 refers to the moving positron and to the initially static electron. So the relativistic kinetic energy of the moving positron is:

$$E_1 = \gamma_1 mc^2 = \hbar \omega_1 \quad -(18)$$

and conservation of energy requires that:

$$\gamma_1 mc^2 + mc^2 = E_2 + E_3 \quad -(19)$$

where:

$$E_2 = \hbar \omega_2 \quad -(20)$$

$$E_3 = \hbar \omega_3 \quad -(21)$$

are the energies of two photons produced by the collision of the positron and electron. It follows that:

$$E_2 + E_3 = (\gamma_1 + 1) mc^2 \neq 2mc^2 \quad -(22)$$

It is easily seen that the point of view of the standard physics is incorrect because the sum of the photon energies is not twice the rest energy of the positron or electron. It is difficult to know why such a fundamental error has been perpetrated dogmatically.

The correct Eq. (19) is:

$$\gamma_1 mc^2 + mc^2 = \hbar\omega_2 + \hbar\omega_3 + E \quad - (23)$$

where

$$E = (\gamma_1 + 1)mc^2 - \hbar(\omega_2 + \omega_3) \quad - (24)$$

is the relativistic kinetic energy:

$$T = (\gamma_1 - 1)mc^2. \quad - (25)$$

The energy E is transmuted into many processes as is well known, i.e. the high energy collision of a positron and electron produces many new particles in addition to photons.

As shown in UFT171 the standard theory of positron electron annihilation collapses because it is an example of equal mass scattering. The problem is that the electron to positron scattering is being considered as an elastic collision. More generally, both particle collision theory and LENR theory result in energy being released, so they are endoergic collisions {11} of the type:

$$\gamma + e^- = \gamma + e^- + E \quad - (26)$$

$$e^+ + e^- = \gamma + \gamma + E \quad - (27)$$

where the energy E is released. In electron positron collision itis released as new particles, and in LENR as energy from nuclear fusion. Therefore the correct and self consistent equation of electron positron annihilation is:

$$e^+ + e^- = \gamma + \gamma + E \quad - (28)$$

The remarkable thing about the standard Compton theory is that it is the only particle collision theory that is an elastic process. The Compton theory appears to work if and only if the photon is massless, but that introduces all kinds of problems as is well known {12}. As soon as photon mass is introduced into Compton theory, the latter collapses entirely into nonsense, as shown in several ways in UFT158 to UFT171 and recent UFT papers. As this section shows, the reason is that no particle collision process can be an elastic process when both masses are finite.

The standard Compton theory also bears a remarkable similarity to the standard Dirac equation when the minimal prescription is used to describe photon electron interaction. This can be shown straightforwardly as follows. The basic equations of the standard Compton theory can be written as:

$$\omega + x_2 = \omega' + \omega'' \quad -(29)$$

and

$$\underline{p} = \underline{p}' + \underline{p}'' \quad -(30)$$

where

$$x_2 = mc^2 / \hbar. \quad -(31)$$

Therefore:

$$\omega'' = x_2 + \omega - \omega' \quad -(32)$$

and

$$\underline{p}'' = \underline{p} - \underline{p}'. \quad -(33)$$

Defining:

$$E'' = \hbar\omega'' \quad -(34)$$

then the Einstein energy equation for the scattered electron demands that:

$$(E - E' + mc^2)^2 = c^2(\underline{p} - \underline{p}')^2 + m^2c^4 \quad -(35)$$

It follows that:

$$E - E' + mc^2 = \frac{c^2(\mathbf{p} - \mathbf{p}')^2}{E - E' + mc^2} + \frac{m^2c^4}{E - E' + mc^2} \quad -(36)$$

which can be written as:

$$\left(\omega - \omega' + \frac{mc^2}{\hbar}\right)^2 = \frac{c^2}{\hbar^2}\left(p^2 + p'^2 - 2pp'\cos\theta\right) + \left(\frac{mc^2}{\hbar}\right)^2. \quad -(37)$$

This is similar to the formalism developed in UFT172 to UFT179 for the fermion equation, the correct development of the Dirac equation. For the "massless" photon:

$$p = \hbar\kappa = \hbar\frac{\omega}{c}, \quad p' = \hbar\frac{\omega'}{c} = \hbar\kappa' \quad -(38)$$

and it follows that:

$$\left(\omega - \omega' + \frac{mc^2}{\hbar}\right)^2 = \omega^2 + \omega'^2 - 2\omega\omega' + 2\left(\frac{mc^2}{\hbar}\right)(\omega - \omega') \quad -(39)$$

which is the Compton formula:

$$\omega - \omega' = \left(\frac{\hbar}{mc^2}\right)\omega\omega'(1 - \cos\theta) \quad -(40)$$

QED.

The Compton formula follows from the relativistic equation (35) of the scattered electron, i.e. the equation:

$$E'' = \gamma'' mc^2 = \hbar\omega''. \quad -(41)$$

Eq. (36) may be written as:

$$E - E' + mc^2 = \frac{1}{m}(\mathbf{p} - \mathbf{p}')^2\left(1 + \frac{E - E'}{mc^2}\right)^{-1} + mc^2\left(1 + \frac{E - E'}{mc^2}\right) \quad -(42)$$

If:

$$E - E' << mc^2 \quad -(43)$$

then:

$$E - E' = \frac{1}{2m}\left(\underline{p} - \underline{p}'\right)^2 \left(1 - \frac{E - E'}{mc^2}\right) \quad -(44)$$

i.e. :

$$E - E' \sim \frac{1}{2m}\left(\underline{p} - \underline{p}'\right)^2. \quad -(45)$$

In this limit it is clear that E and E' are approximated by non relativistic kinetic energies. For the photon they are defined in general by:

$$E = \hbar\omega = \gamma m_1 c^2 \quad -(46)$$
$$E' = \hbar\omega' = \gamma' m_1 c^2 \quad -(47)$$

where m_1 is the photon mass. In the standard physics it is assumed that the photon is massless and travels at c in the vacuum, so it is assumed that:

$$m_1 = 0, \ \gamma = \gamma' \rightarrow \infty. \quad -(48)$$

Eq. (45) may be written as:

$$\hbar\left(\omega - \omega'\right) = \frac{1}{2m}\left(\frac{\hbar}{c}\right)\left(\omega^2 + \omega'^2 - 2\omega\omega'\cos\theta\right) \quad -(49)$$

i. e.

$$\omega - \omega' = \frac{\hbar}{mc^2}\left(\frac{1}{2}\left(\omega^2 + \omega'^2\right) - \omega\omega'\cos\theta\right) \quad -(50)$$

From Eqs. (40) and (50) it is seen that the Compton formula (40) in the approximation (43) is equivalent to the approximation:

$$\omega^2 + \omega'^2 = 2\omega\omega' \quad -(51)$$

which is equivalent in turn to:

$$(\omega + \omega')^2 = \omega^2 + \omega'^2 + 2\omega\omega' \sim 4\omega\omega' \quad -(52)$$

or:

$$\omega \sim \omega' \quad -(53)$$

self consistently, QED.

From Eq. (61) of UFT172, the ECE fermion equation used with the minimal prescription produces:

$$(E - e\phi)^2 - m^2c^4 = c^2\underline{\sigma}\cdot(\underline{p} - e\underline{A})\,\underline{\sigma}\cdot(\underline{p} - e\underline{A}) \quad -(54)$$

for the interaction of a photon and electron. The SU(2) basis is used in Eq. (54) as is well known. If $\underline{p}$ and $\underline{A}$ are real valued then Eq. (54) is:

$$(E - e\phi)^2 = c^2(\underline{p} - e\underline{A})^2 + m^2c^4 \quad -(55)$$

Eqs. (35) and (55) are the same if:

$$e\phi = E' - mc^2 \quad -(56)$$

and

$$\underline{p}' = e\underline{A} \quad -(57)$$

The process being described in Eq. (55) is:

$$E'' \rightarrow E - E' + mc^2 = E - e\phi, \quad -(58)$$

$$\underline{p}'' \rightarrow \underline{p} - \underline{p}' = \underline{p} - e\underline{A} \quad -(59)$$

and the interaction of the electron and photon is described semi classically with a classical scalar potential ϕ and vector potential $\underline{A}$. This process is:

$$\underline{p}' + \underline{p}'' \rightarrow \underline{p} \quad -(60)$$

and

$$E'' + E \rightarrow E + mc^2 \quad -(61)$$

Eq. (60) is the time reversal of Eq. (8), and Eq. (61) is the time reversal of Eq. (7). From this point a relativistic quantum theory of Compton scattering can be developed, and the whole procedure developed into a theory of inelastic scattering.

Several notes accompanying UFT247 on www.aias.us develop the inelastic particle collision theory with applications to processes such as LENR. To complete this section we follow the method of note 247(4) in developing an inelastic scattering theory of LENR. Consider a particle of mass m_1 colliding with an initially stationary particle of mass m_2 to give particles of mass m_3 and m_4 as LENR products with release of energy E. The equations of conservation of energy and momentum are:

$$\gamma m_1 c^2 + m_2 c^2 = \gamma' m_3 c^2 + \gamma'' m_4 c^2 + E \quad -(62)$$

and

$$\underline{p} = \underline{p}' + \underline{p}'' \quad -(63)$$

in which the ECE duality equations are:

$$\begin{aligned} E_1 &= \hbar\omega = \gamma m_1 c^2, & \underline{p} &= \hbar \underline{\kappa} = \gamma m_1 \underline{v}, \\ E_2 &= \hbar\omega_0 = m_2 c^2, & \underline{p}' &= \hbar \underline{\kappa}' = \gamma' m_3 \underline{v}', \\ E_3 &= \hbar\omega' = \gamma' m_3 c^2, & \underline{p}'' &= \hbar \underline{\kappa}'' = \gamma'' m_4 \underline{v}''. \\ E_4 &= \hbar\omega'' = \gamma'' m_4 c^2, & & \end{aligned} \quad -(64)$$

It follows that the energy released in the LENR reaction is:

$$E = x_2 + \hbar(\omega - \omega') \mp \left((\omega - \omega')^2 - c'\right)^{1/2} \quad - (65)$$

where c' is defined by:

$$c' = 2(\omega^2 - x_1^2)^{1/2}(\omega'^2 - x_3^2)^{1/2}\cos\theta - 2\omega\omega' - x_4^2 + x_1^2 + x_3^2 . \quad - (66)$$

This energy is graphed in Section 3 as a function of the various parameters. A more complete relativistic quantum theory is needed to account for quantum tunnelling through the Coulomb barrier.

3. NUMERICAL AND GRAPHICAL ANALYSIS

Section by Horst Eckardt and Douglas Lindstrom

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