PRINCIPLES OF ECE THEORY

A NEW PARADIGM OF PHYSICS

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Chapter 7

Energy from Space Time and Low Energy Nuclear Reactions

7.1 Introduction

These phenomena when viewed as experimental data completely refute the standard model of physics, which is still unable to deal with them. There are many devices available that take energy from space time (www.et3m.net) in a reproducible and repeatable manner. These devices are being used routinely in the best industry. Low energy nuclear reactors (LENR) are about to be mass produced, but the old physics still cannot explain them. A plausible qualitative explanation for such devices has been given by ECE theory through the use of Euler Bernoulli resonance [1]- [10] in equations containing the spin connection. The first example found was spin connection resonance (SCR) in the Coulomb Law, and after that several other mechanisms were found. The theory has been greatly developed independently by Eckardt and Lindstrom. This chapter aims to explain the simple basics of spin connection resonance.

For over a hundred years there have been many reports of devices producing more electric power than inputted to a given device. Many of these reports were not reproducible and repeatable, but in the past thirty years or so the subject has become more scientific, with more details becoming available of circuit design. Some of the reports were of surges or spikes of power which could not be explained conventionally. Some of these were too large to be artifacts. The subject has been hampered greatly by pseudoscience and charlatans, so from the beginning ECE set out to give a rigorous explanation of such phenomena. A qualitative or plausible explanation was sought based on data that were likely to be reproducible and repeatable and to be free of artifact. Conventional electric resonance must be eliminated carefully before a source of energy from space time can be considered as a possible explanation.

In addition to these requirements of Baconian science the circuit design must preferably be made available as the scientific apparatus, in the usual manner of a scientific experiment, but very often no details of apparatus were available. Possibly this may have been due to inventors who were careful to protect patent rights. So scientists have been reluctant to approach these important subject areas in an open minded, scientific, manner. This is a pity because they are of great potential importance to humankind. If there is any chance whatsoever of obtaining energy from spacetime, then that chance should be exploited to the hilt. A coherent theory for such phenomena was not formulated until spin connection resonance was proposed. The Maxwell Heaviside (MH) theory has no explanation for energy from space time, so there has been a historical tendency to dismiss all such data as artifact, or being indicative of a lack of knowledge of basic principles such as conservation of energy. In the past there has been a widespread belief that energy from space time means energy from nothing. This absurd lack of understanding delayed the acceptance of the subject for many years.

In about 2005 one of the authors of this book (MWE) was asked to give an explanation of a very intense resonance peak in apparatus demonstrated to the U. S. Navy by Alex Hill and colleagues (www.aias.us) whose work was first drawn to the attention of MWE by Albert Collins. John Shelburne, a civilian working for the Navy in Florida, asked MWE to give a plausible explanation in terms of the then new ECE theory. The resonance peak was demonstrated to the U. S. Navy by the Alex Hill group, and the Naval civilian staff were satisfied that the effect was free of artifact. There was an intense resonance of electric power which could not be explained by conventional electric resonance theory, based on Euler Bernoulli theory. Subsequently the Alex Hill group developed devices which are now used in Fortune Fifty industry. Observers are allowed to see the devices in operation in Fortune Fifty industry.

7.2 Spin Connection Resonance from the Coulomb Law

In the simplest instance the Coulomb law in ECE theory is given by:

$$\boldsymbol{\nabla} \cdot \mathbf{E} = \frac{\rho}{\epsilon_0} \tag{7.1}$$

where:

$$\mathbf{E} = -\left(\boldsymbol{\nabla} + \boldsymbol{\omega}\right)\phi \tag{7.2}$$

where ϕ is the scalar potential in volts, $\boldsymbol{\omega}$ is the spin connection vector in inverse metres, $\mathbf{E}$ is the electric field strength in volts m^{-1}, ρ is the charge density in Cm^{-3} and ϵ_0 is the S. I. vacuum pemittivity:

$$\epsilon_0 = 8 \cdot 854 \times 10^{-12}\mathrm{J}^{-1}\mathrm{C}^2\mathrm{m}^{-1}. \tag{7.3}$$

Thus:

$$\boldsymbol{\nabla} \cdot \left(\left(\boldsymbol{\nabla} + \boldsymbol{\omega}\right)\phi\right) = -\frac{\rho}{\epsilon_0} \tag{7.4}$$

i.e.:

$$\nabla^2\phi + \boldsymbol{\omega} \cdot \boldsymbol{\nabla}\phi + \left(\boldsymbol{\nabla} \cdot \boldsymbol{\omega}\right)\phi = -\frac{\rho}{\epsilon_0} \tag{7.5}$$

which is an equation capable of giving resonant solutions from the spin connection vector. The Poisson equation does not give resonant solutions. In one Z dimension Eq. (7.5) becomes:

$$\frac{\partial^2\phi}{\partial Z^2} + \omega_Z\frac{\partial\phi}{\partial Z} + \left(\frac{\partial\omega_Z}{\partial Z}\right)\phi = -\frac{\rho}{\epsilon_0}. \tag{7.6}$$

The spin connection in Eq. (7.6) must be:

$$\omega_Z = \frac{2}{Z} \tag{7.7}$$

in order to recover the standard Coulomb law off resonance. This is because:

$$\phi = -\frac{e}{4\pi\epsilon_0 Z}, \quad \frac{\partial\phi}{\partial Z} = \frac{e}{4\pi\epsilon_0 Z^2} = -\frac{\omega_Z}{2}\phi \tag{7.8}$$

in the off resonant condition, giving Eq. (7.7). In the off resonant condition the role of the spin connection is to change the sign of the electric field according to Eq. (7.8). The way in which the field and potential are related is changed, but this has no experimental effect because **E** is effectively changed by $-\mathbf{E}$. With the spin connection (7.7), Eq. (7.6) becomes:

$$\frac{\partial^2\phi}{\partial Z^2}+\frac{2}{Z}\frac{\partial\phi}{\partial Z}-\frac{2}{Z^2}\phi=-\frac{\rho}{\epsilon_0}. \tag{7.9}$$

Now assume that the charge density is initially oscillatory:

$$\rho=\rho^{(0)}\cos\left(\kappa Z\right) \tag{7.10}$$

where κ is a wave number. Thus:

$$\frac{\partial^2\phi}{\partial Z^2}+\frac{2}{Z}\frac{\partial\phi}{\partial Z}-\frac{2}{Z^2}\phi=-\rho^{(0)}\cos\kappa Z. \tag{7.11}$$

The partial derivatives can be changed to total derivatives to give an ordinary differential equation:

$$\frac{d^2\phi}{dZ^2}+\frac{2}{Z}\frac{d\phi}{dZ}-\frac{2}{Z^2}\phi=-\rho^{(0)}\cos\kappa Z. \tag{7.12}$$

Using the well known Euler method this equation can be reduced to an undamped oscillator equation that has resonant solutions, and this was the earliest attempt at developing the theory of spin connection resonance in UFT63.

This was the first plausible explanation of the Alex Hill devices (www.et3m.net) which have been observed over the years by invited experts, the types of device used by Fortune Fifty companies are power saving devices in induction motors, described on the www.et3m.net site, and energy saving devices in lighting. These types of devices can be mass marketed so no better proof of the presence of energy from space time can be given. Initially, this type of energy was known as energy from the vacuum, but such a nomenclature lent itself to misrepresentation and misunderstanding, notably to absurd allegations of perpetual motion. These came about because the vacuum was confused with "nothingness", so that presumably these advocates of perpetual motion thought that no energy can be transferred from nothing to a device. On the contrary, the vacuum of general relativity contains energy, defined by the infinitesimal of proper time and the dynamic metric. This has been known for a century. So transfer of energy occurs from space time to a device. Total energy is conserved.

Therefore the nomenclature of "energy from space time" was adopted and when the request came in from the U. S. Navy to devise an explanation, one was found by using the spin connection and looking for equations with the structure of an Euler Bernoulli equation. It would then be possible for a small driving force to produce a large resonance in output electric power. This theory is the same in structure as conventional electric resonance theory, but the driving force originates in spacetime. The vacuum structure of spacetime has been greatly developed during the evolution of ECE theory by Eckardt and Lindstrom. When first asked to devise a theory the relevant author (MWE) had no details of circuit design, and was given only a qualitative account of the results. So spin connection resonance was devised to provide a qualitative description.

Subsequently it was found that spin connection resonance occurs in magnetostatics (UFT 65). The ECE equations of magnetostatics can be written as:

$$\boldsymbol{\nabla} \cdot \mathbf{B}^a = 0 \tag{7.13}$$

$$\boldsymbol{\nabla} \times \mathbf{B}^a = \mu_0 \mathbf{J}^a \tag{7.14}$$

$$\mathbf{B}^a = \boldsymbol{\nabla} \times \mathbf{A}^a - g\mathbf{A}^b \times \mathbf{A}^c \tag{7.15}$$

and in this case spin connection resonance is defined by the simultaneous equations:

$$\boldsymbol{\nabla} \times \left(\boldsymbol{\nabla} \times \mathbf{A}^a - g\mathbf{A}^b \times \mathbf{A}^c \right) = \mu_0 \mathbf{J}^a \tag{7.16}$$

and:

$$\boldsymbol{\nabla} \cdot \mathbf{A}^b \times \mathbf{A}^c = 0 \tag{7.17}$$

Eq. (7.16) can be developed with the vector identities:

$$\boldsymbol{\nabla} \times \boldsymbol{\nabla} \times \mathbf{A}^a = -\nabla^2 \mathbf{A}^a + \boldsymbol{\nabla} \left(\boldsymbol{\nabla} \cdot \mathbf{A}^a \right) \tag{7.18}$$

and:

$$\boldsymbol{\nabla} \times \left(\mathbf{A}^b \times \mathbf{A}^c \right) = \mathbf{A}^b \boldsymbol{\nabla} \cdot \mathbf{A}^c - \mathbf{A}^c \boldsymbol{\nabla} \cdot \mathbf{A}^b + \left(\mathbf{A}^c \cdot \boldsymbol{\nabla} \right) \mathbf{A}^b - \left(\mathbf{A}^b \cdot \boldsymbol{\nabla} \right) \mathbf{A}^c . \tag{7.19}$$

To simplify the problem for the sake of illustration, assume that the vector potential has no divergence:

$$\boldsymbol{\nabla} \cdot \mathbf{A}^a = \boldsymbol{\nabla} \cdot \mathbf{A}^b = \boldsymbol{\nabla} \cdot \mathbf{A}^c = 0 \tag{7.20}$$

and assume that $\mathbf{A}^c$ is space independent so that:

$$\left(\mathbf{A}^b \cdot \boldsymbol{\nabla} \right) \mathbf{A}^c = \mathbf{0}. \tag{7.21}$$

Eq. (7.16) becomes:

$$\nabla^2 \mathbf{A}^a + g\left(\mathbf{A}^c \cdot \boldsymbol{\nabla}\right)\mathbf{A}^b = -\mu_0 \mathbf{J}^a \tag{7.22}$$

which can be reduced to:

$$\frac{\partial^2 {A^a}_Z}{\partial X^2} + {\kappa_0}^2 {A^a}_Z = \mu_0 {J^a}_Z\,(0)\cos\left(\kappa X\right) \tag{7.23}$$

as in UFT 65. This has the resonant solution:

$${A^a}_Z \to \infty \tag{7.24}$$

at:

$$\kappa = \kappa_0 = \left(g\left(\frac{\partial A_Z}{\partial X}\right)\right)^{\frac{1}{2}}. \tag{7.25}$$

Spin connection resonance can also occur in the Faraday law of induction if it as assumed that there is a magnetic current density:

$$\boldsymbol{\nabla} \times \mathbf{E}^a + \frac{\partial \mathbf{B}^a}{\partial t} = \mu_0 \mathbf{j}^a. \tag{7.26}$$

UFT 65 assumed that there was no scalar potential and that the electric field is defined by:

$$\mathbf{E}^a = -\frac{\partial \mathbf{A}^a}{\partial t} \tag{7.27}$$

leading to another example of spin connection resonance. Subsequently, UFT 74 led to spin connection resonance in magnetic motors (M. W. Evans and H. Eckardt, Physica B, 400, 175 - 179 (2007)). In UFT 92 the theory was developed for the Coulomb law in radial coordinates. The most influential of these early papers of ECE theory is UFT 107, which applied spin connection resonance to the Faraday disk generator using the concept of rotating spacetime. It was shown that at resonance the vector potential goes to infinity, and this seemed to give a plausible qualitative explanation of experimentally observed resonance in a variable frequency Faraday disk generator.

In these early papers the antisymmetry laws of ECE theory had not yet been inferred, but several types of spin connection resonance were defined. As explained already in this book the antisymmetry laws give the possibility of many more resonances and infinities, thus giving plenty of support for the experimental data of the Alex Hill group (www.et3m.net). Subsequently the subject of spin connection resonance was developed by Eckardt and Lindstrom, and an account of these developments is given later in this chapter. The essential point in all these developments is that spin connection resonance occurs only in a theory of general relativity applied to electromagnetism.

The theory continued to develop until it reached the stage described in UFT 259, in which charge current density had been given a geometrical meaning and in which the antisymmetry laws could be incorporated to give spin connection resonance in a simpler way than in the early papers. This is typical of the development of ECE theory, the theory simplified and clarified during the course of 260 papers to date. The latest stages of development are summarized conveniently in the analysis of the Coulomb law using the electric charge density defined by:

$$\rho^a = \epsilon_0 \left(\boldsymbol{\omega}^a{}_b \cdot \mathbf{E}^b - c\mathbf{A}^b \cdot \mathbf{R}^a{}_b \,(\mathrm{orb}) \right) \tag{7.28}$$

where ϵ_0 is the vacuum permittivity, $\boldsymbol{\omega}^a{}_b$ is the spin connection vector, $\mathbf{E}^b$ is the electric field strength, c is the universal constant known as the speed of light, and $\mathbf{R}^a{}_b$ is the orbital part of the curvature vector. As explained already in this book the electric field strength is:

$$\mathbf{E}^a = -c\boldsymbol{\nabla} A^a{}_0 - \frac{\partial \mathbf{A}^a}{\partial t} - c\omega^a{}_{0b}\mathbf{A}^b + cA^b{}_0\boldsymbol{\omega}^a{}_b \tag{7.29}$$

where the 4-potential is defined by:

$$A^a{}_\mu = (A^a{}_0, -\mathbf{A}^a) = \left(\frac{\phi^a}{c}, -\mathbf{A}^a \right) \tag{7.30}$$

where ϕ^a is the scalar potential. The electric current density is defined by:

$$\mathbf{J}^a = \epsilon_0 c \left(\omega^a{}_{0b}\mathbf{E}^b - cA^b{}_0\mathbf{R}^a{}_b \,(\mathrm{orb}) + c\boldsymbol{\omega}^a{}_b \times \mathbf{B}^b - c\mathbf{A}^b \times \mathbf{R}^a{}_b \,(\mathrm{spin}) \right) \tag{7.31}$$

where $\mathbf{R}^a{}_b$ (spin) is the spin part of the curvature vector and where $\mathbf{B}^b$ is the magnetic flux density.

As discussed in UFT 259 the equations of electrostatics in ECE theory are

$$\boldsymbol{\nabla} \cdot \mathbf{E}^a = \boldsymbol{\omega}^a{}_b \cdot \mathbf{E}^b \tag{7.32}$$

$$\omega^a{}_{0b} \cdot \mathbf{E}^b = \phi^b \mathbf{R}^a{}_b \,(\mathrm{orb}) \tag{7.33}$$

$$\boldsymbol{\omega}^a{}_b \times \mathbf{E}^b + \phi^b \mathbf{R}^a{}_b \,(\mathrm{spin}) = \mathbf{0} \tag{7.34}$$

$$\mathbf{E}^a = -\boldsymbol{\nabla}\phi^a + \phi^b \boldsymbol{\omega}^a{}_b \tag{7.35}$$

In order to obtain spin connection resonance Eq. (7.32) must be extended to:

$$\boldsymbol{\nabla}\cdot\mathbf{E}^a=\boldsymbol{\omega}^a{}_b\cdot\mathbf{E}^b-c\mathbf{A}^b\,(\mathrm{vac})\cdot\mathbf{R}^a{}_b\,(\mathrm{orb}) \tag{7.36}$$

where $\mathbf{A}^b$ is a vacuum potential of ECE theory. The static electric field is:

$$\mathbf{E}^a=-\boldsymbol{\nabla}\phi^a+\phi^b\boldsymbol{\omega}^a{}_b \tag{7.37}$$

so from Eqs. (7.36) and (7.37) :

$$\nabla^2\phi^a+\left(\boldsymbol{\omega}^a{}_b\cdot\boldsymbol{\omega}^b{}_c\right)\phi^c=\boldsymbol{\nabla}\cdot\left(\phi^b\boldsymbol{\omega}^a{}_b\right)+\boldsymbol{\omega}^a{}_b\cdot\boldsymbol{\nabla}\phi^b+c\mathbf{A}^b\,(\mathrm{vac})\cdot\mathbf{R}^a{}_b\,(\mathrm{orb})\,. \tag{7.38}$$

The ECE anti symmetry law means that:

$$-\boldsymbol{\nabla}\phi^a=\phi^b\boldsymbol{\omega}^a{}_b \tag{7.39}$$

leading to the Euler Bernoulli resonance equation:

$$\nabla^2\phi^a+\left(\boldsymbol{\omega}^a{}_b\cdot\boldsymbol{\omega}^b{}_c\right)\phi^c=\frac{1}{2}c\mathbf{A}^b\,(\mathrm{vac})\cdot\mathbf{R}^a{}_b\,(\mathrm{orb}) \tag{7.40}$$

and undamped spin connection resonance. The left hand side contains the Hooke's law term and the right hand side the driving term originating in a vacuum potential. However tiny this term may be it can be amplified greatly by undamped resonance, confirming the Alex hill result in another way. This is the most complete theory of Coulomb law resonance to date.

Denoting:

$$\rho^a\,(\mathrm{vac})=\frac{\epsilon_0 c}{2}\mathbf{A}^b\,(\mathrm{vac})\cdot\mathbf{R}^a{}_b\,(\mathrm{orb}) \tag{7.41}$$

the equation becomes:

$$\nabla^2\phi^a+\left(\boldsymbol{\omega}^a{}_b\cdot\boldsymbol{\omega}^b{}_c\right)\phi^c=\frac{\rho^a\,(\mathrm{vac})}{\epsilon_0}. \tag{7.42}$$

The left hand side is a field property and the right hand side is a property of the ECE vacuum. In the simplest case:

$$\nabla^2\phi+\omega^2{}_0\phi=\frac{\rho\,(\mathrm{vac})}{\epsilon_0} \tag{7.43}$$

and produces undamped resonance if the driving term is oscillatory as already described in this book.

7.3 Low Energy Nuclear Reactions (LENR)

This is a most promising source of new energy, the most well known device being the Rossi reactor recently purchased for commercialization. Again the standard model of electromagnetism has no coherent explanation for the phenomenon, in which nuclear fusion occurs in simple apparatus with release of useful heat. Some of the devices used to produce this heat are well known and available in all detail. The technique has been subject to numerous independent assessments and checks for repeatability and reproducibility. Initially it was known as cold fusion, famously discovered by Pons and Fleischman in the University of Utah. Their discoveries were supported initially by the State of Utah. It was difficult initially to prove that cold fusion was reproducible and repeatable, so there ensued a very long debate which is still going on. However the LENR technique is being commercialized, and subject to control of the heat produced, will be available for domestic use.

LENR devices are already being used for military and other applications and have been subjected to the usual testing and certifying. Some academic departments are also dedicated to LENR, and many conferences, journals and newsletters dedicated to the subject. In the economics department in the University of Utah, models are being developed to research the effect of LENR on future economies. The availability of cheap and clean energy is a pre-requisite for economic growth. Stephen Bannister for example is currently preparing a Thesis on this topic in the University of Utah's Department of Economics, a Thesis which compares the first industrial revolution in Britain with the second industrial revolution expected to occur as the result of the energy techniques described in this chapter. During one such conference approximately a year and a half ago one of the authors of this book (MWE) was asked to devise a theoretical explanation for low energy nuclear reactions in terms of ECE theory in order to devise a solid and coherent framework for its development within the scope of a unified field theory. There are many theories of LENR but no consensus as to the origins of the energy needed to cause a nuclear reaction in simple apparatus in the laboratory.

The initial response to this request was UFT 226 on www.aias.us, in which a general theory of particle collisions was developed. This is overviewed briefly in this section. Consider two particles of 4-momenta p^μ and ${p^\mu}_1$:

$$p^\mu = \left(\frac{E}{c}, \mathbf{p}\right), \quad {p^\mu}_1 = \left(\frac{E_1}{c}, \mathbf{p}_1\right). \tag{7.44}$$

In the minimal prescription on the semi classical level the collision of these particles is described by:

$$p^{\mu} \rightarrow p^{\mu} + p^{\mu}{}_{1} \tag{7.45}$$

$$E \rightarrow E + E_1 \tag{7.46}$$

$$\mathbf{p} \rightarrow \mathbf{p} + \mathbf{p}_1 \tag{7.47}$$

where E is the relativistic energy

$$E = \gamma m c^2 \tag{7.48}$$

and $\mathbf{p}$ the relativistic momentum:

$$\mathbf{p} = \gamma m \mathbf{v}. \tag{7.49}$$

The Lorentz factor is defined by:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \tag{7.50}$$

where $\mathbf{v}$ is the velocity of a particle of mass m and where c is the speed of light in vacuo. Eq. (7.49) implies the Einstein field equation:

$$E^2 = p^2 c^2 + m^2 c^4 \tag{7.51}$$

which can be written as:

$$E^2 - m^2 c^4 = \left(E - mc^2\right)\left(E + mc^2\right) = c^2 p^2. \tag{7.52}$$

From Eqs. (7.45) and (7.51):

$$\left(E + E_1\right)^2 = c^2 \left(p + p_1\right)^2 + m^2 c^4 \tag{7.53}$$

which is the classical relativistic description of particle interaction in the minimal prescription. From Eq. (7.53):

$$\left(E + E_1\right)^2 - m^2 c^4 = c^2 \left(p + p_1\right)^2 \tag{7.54}$$

so the relativistic kinetic energy is:

$$T = E + E_1 - mc^2 = \frac{c^2 \left(p + p_1\right)^2}{E + E_1 + mc^2}. \tag{7.55}$$

This kinetic energy is a limit of the ECE fermion equation, which is derived from the Cartan geometry used in this book. The concepts of particle mass m and m_1 are limits of the more general R factor of the ECE wave equation described in UFT 181 and UFT 182. After a series of approximations described in UFT 226, and similar to those used in the derivation of the fermion equation described already in this book, the energy E can be expressed as:

$$E = \frac{c^2 (p + p_1)^2}{2mc^2 + E_1} + mc^2 \tag{7.56}$$

and the kinetic energy as:

$$T = E + E_1 - mc^2 \sim E - mc^2. \tag{7.57}$$

In order to quantize the theory the fermion equation is used as described in UFT 226 to give the hamiltonian operator:

$$H\psi = (H_1 + H_2)\,\psi \tag{7.58}$$

where:

$$H_1\psi = \frac{1}{2m}\left(\boldsymbol{\sigma}\cdot(-i\hbar\boldsymbol{\nabla} + \mathbf{p}_1)\,\boldsymbol{\sigma}\cdot(-i\hbar\boldsymbol{\nabla} + \mathbf{p}_1)\right)\psi \tag{7.59}$$

and

$$H_2\psi = \left(-\boldsymbol{\sigma}\cdot(-i\hbar\boldsymbol{\nabla} + \mathbf{p}_1)\,\frac{E_1}{4m^2c^2}\,(-i\hbar\boldsymbol{\nabla} + \mathbf{p}_1)\right)\psi. \tag{7.60}$$

In Eq. (7.58):

$$\boldsymbol{\sigma}\cdot(\mathbf{p} + \mathbf{p}_1)\,\boldsymbol{\sigma}\cdot(\mathbf{p} + \mathbf{p}_1) = p^2 + {p_1}^2 + \mathbf{p}_1\cdot\mathbf{p} + \mathbf{p}\cdot\mathbf{p}_1 + i\boldsymbol{\sigma}\cdot(\mathbf{p}_1\times\mathbf{p} + \mathbf{p}\times\mathbf{p}_1) \tag{7.61}$$

so the first type of hamiltonian becomes:

$$H_1 = -\frac{\hbar^2}{2m}\nabla^2 + \frac{{p_1}^2}{2m} + \frac{i\hbar}{2m}\left(\mathbf{p}_1\cdot\boldsymbol{\nabla} + \boldsymbol{\nabla}\cdot\mathbf{p}_1\right) + \frac{\hbar}{2m}\boldsymbol{\sigma}\cdot\left(\mathbf{p}_1\times\boldsymbol{\nabla} + \boldsymbol{\nabla}\times\mathbf{p}_1\right) \tag{7.62}$$

and operates on the wave function to give energy eigenvalues. As described in UFT 226 the hamiltonian operator may be simplified to give:

$$H_1 = -\frac{\hbar^2}{2m}\nabla^2 + \frac{{p_1}^2}{2m} + \frac{i\hbar}{2m}\left(\boldsymbol{\nabla}\cdot\mathbf{p}_1 + 2\mathbf{p}_1\cdot\boldsymbol{\nabla}\right) + \frac{\hbar}{2m}\boldsymbol{\sigma}\cdot\boldsymbol{\nabla}\times\mathbf{p}_1. \tag{7.63}$$

In the generally covariant format of this theory the concept of mass is generalized to curvature R using the Hamilton Jacobi equation:

$$(p^\mu - \hbar\kappa^\mu)(p_\mu - \hbar\kappa_\mu) = {m_0}^2 c^2 \tag{7.64}$$

as in UFT 182 on www.aias.us. Eq. (7.64) may be written as:

$$p^\mu p_\mu = \hbar^2 R_1 + {m_0}^2 c^2. \tag{7.65}$$

Using this theory it is possible to consider the four momentum ${p^\mu}_1$ of particle 1 interacting with a matter wave 2 defined by the wave vector ${\kappa^\mu}_2$. Particle 1 is also a matter wave:

$${p^\mu}_1 = \hbar{\kappa^\mu}_1. \tag{7.66}$$

In UFT 182 it was shown that the interaction is described by:

$$\left(\Box + R_2 + \left(\frac{m_{10}c}{\hbar}\right)^2\right)\psi_1 = 0 \tag{7.67}$$

where the R_2 parameter is:

$$R_2 = \left(\frac{m_2 c}{\hbar}\right)^2 \tag{7.68}$$

and where the concept of interacting mass is defined as:

$$m_2 = \frac{\hbar}{c}\left(2\left(\frac{\omega_1\omega_2}{c^2} - \kappa_1\kappa_2\right) - \left(\frac{{\omega_2}^2}{c^2} - {\kappa_2}^2\right)\right)^{\frac{1}{2}}. \tag{7.69}$$

Therefore in this general ECE theory it is possible to think of a quantum of space time energy being absorbed during a LENR reaction. This idea generalizes the Planck concept of photon energy to particle energy.

A low energy nuclear reaction can be exemplified as follows:

$$^{64}\mathrm{Ni} + \mathrm{p} =^{63} \mathrm{Cu} + 2\,\mathrm{n}. \tag{7.70}$$

Here, ^{64}Ni has 36 neutrons and 28 protons, and ^{63}Cu has 34 neutrons and 29 protons. So ^{64}Ni is transmuted into ^{63}Cu with release of two neutrons. The theory must explain why this nuclear reaction occurs. Nickel is transmuted to copper with the release of usable heat and this reaction can be made to occur in simple apparatus in the laboratory. It does not need the vast amount of expenditure of conventional nuclear fusion research. Using the theory of this section the interacting mass is:

$$m = \frac{\hbar}{c}\left(\frac{\omega^2}{c^2} - \kappa^2\right)^{\frac{1}{2}} \tag{7.71}$$

and the total mass of the nickel atom during interaction increases to:

$$M = \left(m^2 + {m_0}^2\right)^{\frac{1}{2}} \tag{7.72}$$

with concomitant energy:

$$E_0 = Mc^2 \tag{7.73}$$

so that a nuclear reaction occurs, a LENR reaction.

This is a simple first theory, which is a plausible explanation of LENR. In UFT 227 a more general theory was considered to develop an expression for the mass M of a fused nucleus when reactants 1 and 2 produce products 3 and 4. Total energy momentum is conserved as follows:

$$p^{\mu}{}_1 + p^{\mu}{}_2 = p^{\mu}{}_3 + p^{\mu}{}_4. \tag{7.74}$$

As shown in UFT 227 this equation can be expressed as:

$$(E_1 + E_2)^2 - (\mathbf{p}_1 + \mathbf{p}_2) \cdot (\mathbf{p}_1 + \mathbf{p}_2) = M^2 c^4 \tag{7.75}$$

where:

$$M^2 = {m_1}^2 + {m_2}^2 + 2m_1 m_2 \left(\gamma_1\gamma_2 - \left({\gamma_1}^2 - 1\right)^{\frac{1}{2}} \left({\gamma_2}^2 - 1\right)^{\frac{1}{2}} \cos\theta\right) \tag{7.76}$$

in which the angle θ is defined as

$$(\mathbf{p}_1 + \mathbf{p}_2) \cdot (\mathbf{p}_1 + \mathbf{p}_2) = p^2{}_1 + p^2{}_2 + 2p_1 p_2 \cos\theta. \tag{7.77}$$

In the non relativistic limit:

$$v_1 \ll c, v_2 \ll c \tag{7.78}$$

Eq. (7.76) becomes:

$$M^2 = {m_1}^2 + {m_2}^2 + 2m_1 m_2 = (m_1 + m_2)^2 \tag{7.79}$$

so in this limit M is the sum of m_1 and m_2. Otherwise there is a mass discrepancy or difference:

$$\Delta m = \left({m_1}^2 + {m_2}^2 - M^2\right)^{\frac{1}{2}} \tag{7.80}$$

which gives rise to the energy released in nuclear fusion as heat and light.

This classical relativistic theory was quantized in UFT 227 using the fermion equation for the fusion of two atoms 1 and 2. The attractive nuclear strong forces are denoted V_1 and V_2, their sum being:

$$V = V_1 + V_2. \tag{7.81}$$

The total relativistic energy of nuclei 1 and 2 is:

$$E = E_1 + E_2 \tag{7.82}$$

and their fused mass is M. The vector sum of their relativistic momenta is:

$$\mathbf{p} = \mathbf{p}_1 + \mathbf{p}_2. \tag{7.83}$$

The fermion equation for this nuclear fusion reaction is:

$$((E-V) + c\boldsymbol{\sigma}\cdot\mathbf{p})\,\phi^L = Mc^2\phi^R \tag{7.84}$$

$$((E-V) + c\boldsymbol{\sigma}\cdot\mathbf{p})\,\phi^R = Mc^2\phi^L \tag{7.85}$$

which can be developed as the Schroedinger type equation:

$$H\psi = E\psi \tag{7.86}$$

where the hamiltonian operator is:

$$H = H_1 + H_2 \tag{7.87}$$

where:

$$H_1 = Mc^2 + V - \frac{\hbar^2\nabla^2}{2m} \tag{7.88}$$

and:

$$H_2 = \frac{1}{4M^2c^2}\boldsymbol{\sigma}\cdot\mathbf{p}\,V\,\boldsymbol{\sigma}\cdot\mathbf{p} \tag{7.89}$$

giving the nuclear energy levels.

In UT 227 the well known Woods Saxon potential was used to model Eq. (7.86). It is described by:

$$V = -V_0\left(1 + \exp\left(\frac{r-R}{a}\right)\right)^{-1} \tag{7.90}$$

where V_0 is the potential well depth, a is the surface thickness of the nucleus, and R is the nuclear radius. It can be approximated roughly by the harmonic oscillator potential:

$$V = \frac{1}{2}kr^2 - V_0 \tag{7.91}$$

where k is the spring constant of Hooke's law, so Eq. (7.86) becomes:

$$H_1\psi = \left(-\frac{\hbar^2\nabla^2}{2m} + \frac{1}{2}kr^2 + Mc^2 - V_0\right)\psi. \tag{7.92}$$

The nuclear energy levels of the fused nucleus in this approximation are the well known energy levels of the harmonic oscillator:

$$E = \left(n + \frac{1}{2}\right)\hbar\omega \tag{7.93}$$

where:

$$n = 0, 1, 2, \ldots \tag{7.94}$$

and where:

$$\omega = \left(\frac{k}{M}\right)^{\frac{1}{2}}. \tag{7.95}$$

In a rough approximation as described in UFT 227 the attractive nuclear strong force can be written as:

$$\mathbf{F}_N \sim \frac{1}{4a}\left(1 - \frac{r-R}{a}\right)\mathbf{e}_r \tag{7.96}$$

and the spin orbit energy from the nuclear fermion equation (7.86) is:

$$H_{so}\psi = \frac{\hbar}{16M^2c^2a^2}\,\boldsymbol{\sigma}\cdot\mathbf{L}\,\psi. \tag{7.97}$$

The spin orbit energy can be used to explain many features of nuclear physics and is its most important property.

The energy levels of the fused nucleus are in excited states, and the nucleus disintegrates to give products 3 and 4 accompanied by energy:

$$\Delta E_0 = (m_1 + m_2 - M)\,c^2 \tag{7.98}$$

In UFT 228 quantum tunnelling theory was introduced by writing the Einstein energy equation:

$$E^2 = p^2c^2 + m^2c^4 \tag{7.99}$$

as

$$E = \gamma mc^2 = \frac{1}{\gamma m}\left(p^2 + m^2c^2\right). \tag{7.100}$$

Eq. (7.100) becomes a Schroedinger equation:

$$H\psi = E\psi \tag{7.101}$$

with the hamiltonian:

$$H = \frac{1}{\gamma m}\left(p^2 + m^2c^2\right) \tag{7.102}$$

and energy levels:

$$E = \gamma mc^2. \tag{7.103}$$

It follows that:

$$p^2\psi = -\hbar^2\nabla^2\psi = m^2c^2\left(\gamma^2 - 1\right)\psi. \tag{7.104}$$

The four momentum is defined by:

$$p^\mu = i\hbar\partial^\mu = \hbar\kappa^\mu \tag{7.105}$$

where:

$$p^\mu = \left(\frac{E}{c}, \mathbf{p}\right), \tag{7.106}$$

$$\partial^\mu = \left(\frac{1}{c}\frac{\partial}{\partial t}, -\boldsymbol{\nabla}\right), \tag{7.107}$$

$$\kappa^\mu = \left(\frac{\omega}{c}, \boldsymbol{\kappa}\right). \tag{7.108}$$

Here ω is the frequency of the matter wave, and $\boldsymbol{\kappa}$ the wave number. Therefore:

$$p^2\psi = \hbar^2\kappa^2\psi = m^2c^2\left(\gamma^2 - 1\right)\psi = \left(\frac{E^2}{c^2} - m^2c^2\right)\psi. \tag{7.109}$$

For a free wave / particle:

$$\kappa = \frac{mc}{\hbar}\left(\gamma^2 - 1\right)^{\frac{1}{2}}. \tag{7.110}$$

For the purposes of the development of quantum tunnelling theory denote:

$$k = \frac{mc}{\hbar}\left(\gamma^2 - 1\right)^{\frac{1}{2}} \tag{7.111}$$

In the presence of potential energy V the operator (7.102) becomes:

$$H = \frac{1}{\gamma m}\left(p^2 + m^2c^2\right) + V \tag{7.112}$$

so:

$$p^2\psi = \left(\gamma m\left(E - V\right) - m^2c^2\right)\psi \tag{7.113}$$

and

$$\kappa^2 = \frac{1}{\hbar^2}\left(\gamma m\left(E - V\right) - m^2c^2\right). \tag{7.114}$$

In quantum tunnelling theory E < V, so

$$E - V < 0. \tag{7.115}$$

Define:

$$\kappa = \frac{1}{\hbar}\left(\gamma m\left(V - E\right)\right)^{\frac{1}{2}}. \tag{7.116}$$

Denoting the rest wave number as:

$$\kappa_0 = \frac{mc}{\hbar} \tag{7.117}$$

we arrive at the definition:

$$\kappa^2 + \kappa_0^2 = \frac{\gamma m}{\hbar^2}\left(V - E\right). \tag{7.118}$$

Eq. (7.111) can be written as:

$$\kappa^2 + \kappa_0^2 = \gamma^2\left(\frac{mc}{\hbar}\right)^2 \tag{7.119}$$

so:

$$\frac{p^2}{2m}\psi = \frac{mc^2}{2}\left(\gamma^2 - 1\right)\psi. \tag{7.120}$$

In the non-relativistic quantum limit, as shown in UFT 228:

$$\nabla^2\psi = -\left(\frac{2mE}{\hbar^2}\right)\psi \tag{7.121}$$

giving the transmission coefficient:

$$T = 8\kappa^2 k^2 \left(\left(k^2+\kappa^2\right)\cosh\left(4\kappa a\right) - \left(\kappa^4 + k^4 - 6\kappa k\right)\right)^{-1}, \tag{7.122}$$

for a potential of type:

$$\begin{aligned} &V = 0, \quad x < -a, \\ &V = V_0, \quad -a < x < a, \\ &V = 0, \quad x > a, \\ &E < V_0, \end{aligned} \tag{7.123}$$

in which:

$$\begin{aligned} k^2 = 2mE/\hbar^2, \quad E = mc^2\,\frac{\gamma^2-1}{2}, \\ \kappa^2 = 2m\left(V_0 - E\right)/\hbar^2, \quad E = mc^2\,\frac{\gamma^2-1}{2}. \end{aligned} \tag{7.124}$$

In a graphical analysis the transmission coefficient T of Eq. (7.122) has been calculated for the rectangular barrier (7.123). The coefficient depends on wave vectors k and κ and barrier half-width a. In Fig. 7.1 both a and k have been varied. It can be concluded that T is at maximum when ka as as well as κ are minimal; this corresponds to quantum waves with lowest energy.

Since k and κ depend on the energy E and height of the potential well V_0 (see Eq. (7.124)), it is more conclusive to study the dependence on these parameters. For a special parameter combination, T is quite high in the "forbidden" region, showing the quantum mechanical tunneling behaviour. This is graphed in Fig. 7.2 in a 3D representation.

The tunnelling probability decreases drastically with slightly enhanced masses. Mass is a very sensitive parameter. This can be seen from Fig. 7.3 where we have graphed the mass dependence of T with relativistic velocity ratio v/c as a curve parameter. For $v \to c$ the transmission coefficient degenerates to a delta function at $m = 0$.

It is found using this analysis that the single most important factor is the mass of the incoming particle. The extra ingredient given by ECE theory is the possibility of augmenting the standard quantum tunnelling theory by resonant absorption of quanta of space time energy - energy from space time.

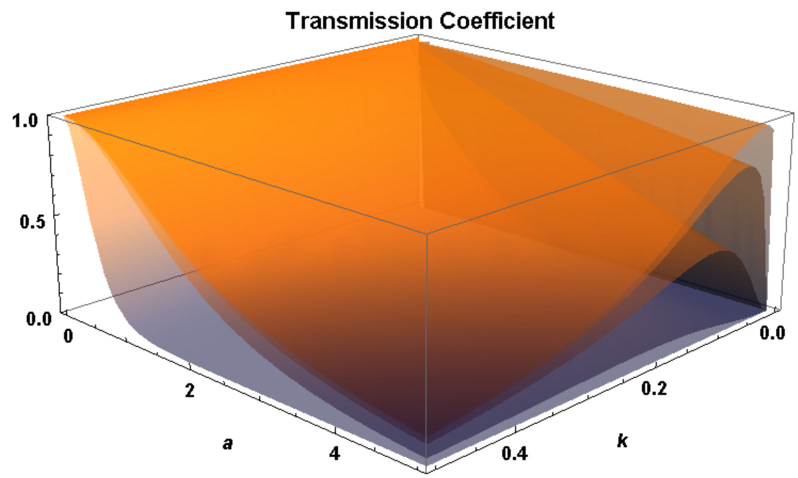

Figure 7.1: Transmission coefficient $T(k, a)$ for five values of κ.

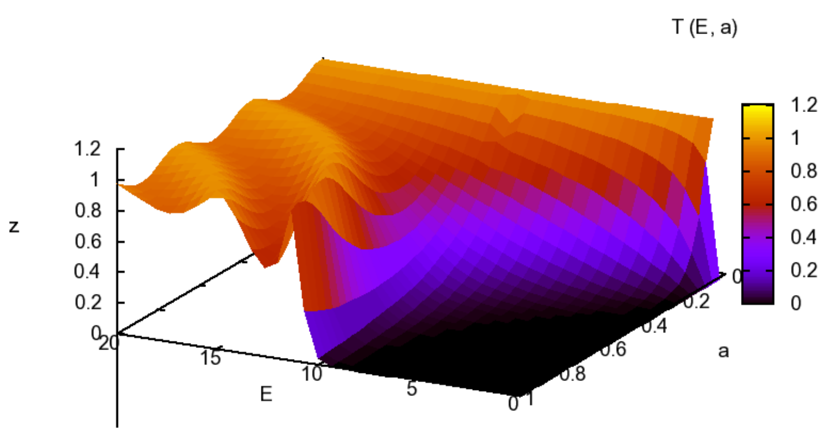

Figure 7.2: Transmission coefficient $T(E, a)$ for $m = \hbar = 1,\ V_0 = 10$.

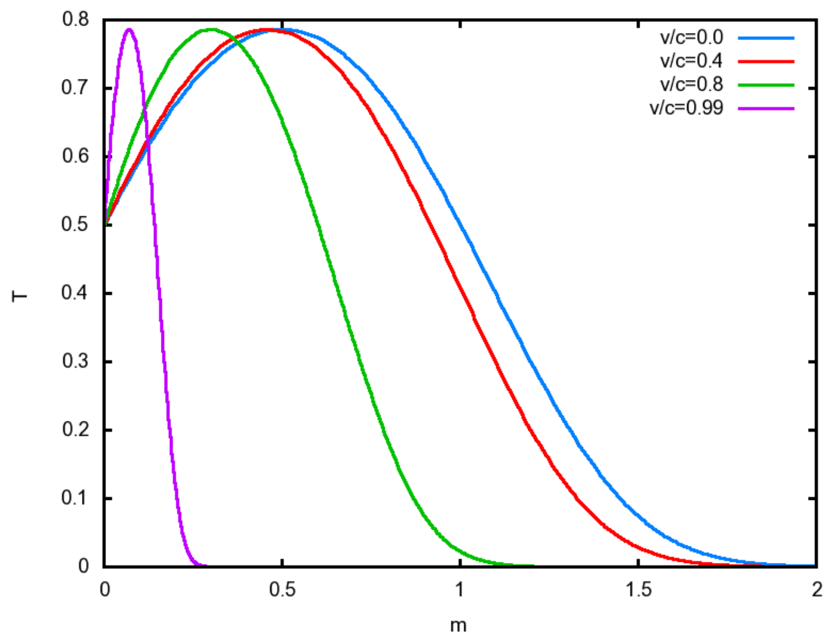

Figure 7.3: Mass dependence of the realtivistic transmission coefficient $T(m)$ for electron-electron tunneling, electrom mass is $m = 1$.