ECE theory of hydrogen bonding.

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Abstract

The Einstein Cartan Evans (ECE) theory is applied to electrodynamics to develop a novel theory of the Coulomb law at a fundamental level. The antisymmetry of the commutator is used in ECE theory to develop relations between vector and scalar potentials, and to develop electrodynamics as a theory of general relativity characterized by the spin connection. The structure of the fundamental laws of electrodynamics remains the same, but the field potential relations are developed to include the spin connection. This results in the possibility of Euler Bernoulli resonance in the Coulomb Law. The latter is the basis of quantum chemistry and the quantum theory of hydrogen bonding.

Keywords: ECE theory, ECE antisymmetry laws, spin connection resonance, density functional methods in the quantum theory of H bonding.

1. Introduction.

The general theory of relativity argues that all physics can be deduced from geometry, notably through use of the metric [1-10], the connection of various non-Euclidean geometries, field potential relations and field and wave equations. The principle of relativity should be applied to all sectors of the unified field: gravitation, electrodynamics, weak and strong fields of force. The dogma of theoretical physics has always maintained that general relativity must be based on the Einstein Hilbert (EH) field equation of 1915 / 1916, but during the course of development of ECE theory this equation has been shown to be incorrect due to the neglect of spacetime torsion (see for example UFT 139 on www.aias.us). The equation has been discarded in favour of new concepts based on a self consistent and well accepted non-Euclidean geometry due to Cartan [11]. Using the minimum of hypotheses, the geometrical structure of Cartan has been translated directly into field potential equations and unified field equations. This produces a plausible unified field theory which can be used for engineering, notably the urgent problem of finding new sources of energy and the development of industries based on counter gravitation. This is known as Einstein Cartan Evans (ECE) theory to denote that the original ideas of Einstein are still usable, but there are major errors in his work. For example in UFT 150 on www.aias.us it is shown that Einstein´s theory of light deflection due to gravitation is wildly incorrect by six orders of magnitude. The theory by Einstein could not possibly have been "verified" by Eddington and in UFT 150 it is corrected to give the first plausible estimate of photon mass by light deflection due to gravitation using data from NASA Cassini.

In Section 2 the antisymmetry of the commutator of covariant derivatives is used to deduce fundamental antisymmetry constraints on the familiar scalar and vector potentials of electrodynamics and electrostatics. These constraints mean that the spin connection must be used in electrodynamics, and mean that the U(1) sector symmetry of dogmatic unified field theories of the twentieth century could not have led to correct results. The key equations of the ECE antisymmetry laws are reviewed for convenience of reference. In Section 3, the spacetime generated Euler Bernoulli resonance is used to demonstrate corrections to the nature of the potentials within a hydrogen atom.

2. Antisymmetry constraints in electrodynamics and electrostatics.

These constraints follow straightforwardly from the antisymmetry of the commutator of covariant derivatives [1-11]:

$$[D_\mu, D_\nu] = -[D_\nu, D_\mu] \tag{1}$$

In electrodynamics [12], the commutator is applied to the gauge field ψ. In the twentieth century dogma known as U(1) gauge theory, this results in the electromagnetic field tensor $F_{\mu\nu}$ as follows:

$$[D_\mu, D_\nu]\, \psi = -i\, g\, F_{\mu\nu}\, \psi \quad . \tag{2}$$

where g is a proportionality factor. In the U(1) gauge theory the electromagnetic tensor is defined as:

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \tag{3}$$

where A_μ is the four potential of Minkowski spacetime. So this theory is restricted at the outset to special relativity (Minkowski spacetime) and in this theory the field and potential are still regarded in the manner of the nineteenth century - as entities superimposed on a frame of reference. The antisymmetry laws of ECE refute this theory entirely as follows, and ECE theory produces an electrodynamics which is a general theory of relativity in a spacetime with curvature and torsion, and in which the electromagnetic field is geometry itself. This ECE theory is in keeping with the philosophy of general relativity, and has been tested extensively [1-10 and www.aias.us]. The ECE theory produces all of the wave and field equations of both quantum and classical physics and successfully unifies general relativity and quantum mechanics in a relatively simple way.

The covariant derivative of the U(1) gauge theory is [12]:

$$D_\mu = \partial_\mu - igA_\mu \tag{4}$$

so

$$[D_\mu, D_\nu]\,\psi = [\partial_\mu - igA_\mu\,, \partial_\nu - igA_\nu\,]\,\psi = -\,ig\,(F_{\mu\nu} - ig\,[A_\mu, A_\nu])\,\psi \tag{5}$$

In U(1) gauge theory the commutator:

$$[A_\mu, A_\nu] = -\,[A_\nu, A_\mu] \tag{6}$$

is dogmatically and incorrectly discarded. The inverse Faraday effect [1-10] shows that this commutator is non zero, and the inverse Faraday effect has been known for 55 years. Yet it is still ignored in U(1) gauge theory, a clear sign of the latter´s dogmatic nature. Using relations such as:

$$[\partial_\mu, A_\nu]\,\psi = (\partial_\mu\, A_\nu)\,\psi \tag{7}$$

$$[\partial_\nu, A_\mu]\,\psi = (\partial_\nu\, A_\mu)\,\psi \tag{8}$$

the U(1) gauge theory produces Eq. (2), and the dogmatists of the twentieth century left it at that.

However, recent scholarship has shown that the dogma falls apart. To see this note that:

$$\partial_\mu\, A_\nu = -\,\partial_\nu\, A_\mu \tag{9}$$

as a direct result [1-10] of commutator antisymmetry. A commutator is always antisymmetric unless its indices are the same, in which case it is always zero. In Riemann geometry [1-11] the commutator has a direct one to one relation with the connection as follows [UFT 139 on www.aias.us], so:

$$[D_\mu, D_\nu]\, V^\sigma = \Gamma^\lambda_{\mu\nu}\, D_\lambda\, V^\sigma + \ldots \qquad (10)$$

where V^σ is a vector (or it can be a tensor [11]) and where $\Gamma^\lambda_{\mu\nu}$ is the connection of Riemann geometry. It is seen that the connection is antisymmetric:

$$\Gamma^\lambda_{\mu\nu} = -\, \Gamma^\lambda_{\nu\mu} \quad . \qquad (11)$$

Yet for over ninety years the dogmatists have perpetrated an incorrect claim that the connection must be symmetric:

$$\Gamma^\lambda_{\mu\nu} = ?\ \Gamma^\lambda_{\nu\mu} \quad . \qquad (12)$$

This is the incorrect symmetry used in the Einstein field equation, so ninety years of work based on that equation has been discarded in ECE theory as incorrect.

Applying:

$$\partial_\mu\, A_\nu + \partial_\nu\, A_\mu = 0 \qquad (13)$$

to U(1) electrodynamics systematically it quickly becomes untenable. For example [1-10]:

$$\nabla\, \phi = \frac{\partial \boldsymbol{A}}{\partial t} \quad . \qquad (14)$$

Using the vector property:

$$\nabla \times \nabla\, \phi = \frac{\partial}{\partial t}\, (\nabla \times \boldsymbol{A}) = \frac{\partial \boldsymbol{B}}{\partial t} \qquad (15)$$

It is seen that

$$\frac{\partial}{\partial t}\, (\nabla \times \boldsymbol{A}) = \boldsymbol{0} \qquad (16)$$

so

$$\frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{0} \qquad (17)$$

and using the Faraday law of induction:

$$\nabla \times \boldsymbol{E} + \frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{0} \qquad (18)$$

results in

$$\nabla \times \boldsymbol{E} = \boldsymbol{0} \quad . \qquad (19)$$

This means that U(1) electrodynamics is confined to a static electric field (19) and a static magnetic field (17). There can be no electromagnetic radiation in U(1) theory, an absurd and incorrect result of dogma repeated uncritically. Even worse, the static electric field is defined on the U(1) level by:

$$\boldsymbol{E} = - \nabla \phi \quad . \tag{20}$$

so:

$$\frac{\partial \boldsymbol{A}}{\partial t} = \boldsymbol{0} \tag{21}$$

However, antisymmetry means that:

$$\nabla \phi = \frac{\partial \boldsymbol{A}}{\partial t} = \boldsymbol{0} \tag{22}$$

so the electric field vanishes completely: there is no static electric field, there is no dynamic electric field in the U(1) dogma. The latter is used to shore up CERN for example. Finally, since:

$$\boldsymbol{E} = 0 \quad , \quad \boldsymbol{A} = 0 \quad , \tag{23}$$

then the static magnetic field vanishes in U(1) dogma. So we are left with nothing at all, despite expenditure of billions of units for funding at CERN. The U(1) dogma is still the cornerstone upon which that venerable white elephant sits.

In the ECE theory the field equations of electrodynamics correctly include the connection [1-10], and the symmetry constraints imposed by the commutator results in [1]:

$$\partial_\mu A_\nu + \partial_\nu A_\mu + \omega_\mu A_\nu + \omega_\nu A_\mu = 0 \quad . \tag{24}$$

In the following section, this equation is developed and applied to the fundamental Coulomb law. The latter is used in the Schroedinger and Dirac equations as is well known, so a fundamental development in the Coulomb law automatically has consequences throughout quantum chemistry, and in the context of this conference, in the theory of H bonding.

3. ECE Model of the Classical Hydrogen Atom

In this section, a model of the classical hydrogen atom is presented from the framework of the ECE electromagnetic theory. Prompted by the manner in which engineers and scientists typically solve systems of partial differential equations, the equations of ECE have been recast using traditional vector calculus [1]. As a review, the development of the ECE equations of electromagnetism is presented here. Full details are available elsewhere [1].

In Cartan geometry, the fundamental unit that describes the geometry is the tetrad, q. The fundamental ansatz of ECE theory is that

$$A = A^{(0)} q \tag{25}$$

where A is the electromagnetic four potential and $A^{(0)}$ is a primordial constant related to the unit of electrical charge. ECE theory is therefore geometry only. We will express the mathematics in a barebones notation and so remove the complication of multiple indices, but also lose some of the intricacies of the Cartan geometry.

The first Cartan structure equation is

$$T = d \wedge q + \omega \wedge q \tag{26}$$

where T is the torsion form, and ω is the spin connection.

The electromagnetic field strength tensor F is then given by

$$F = A^{(0)} T \tag{27}$$

and therefore by equation (26)

$$F = d \wedge A + \omega \wedge A. \tag{28}$$

The first Bianchi identity, relating torsion to curvature, in Cartan geometry is

$$d \wedge T + \omega \wedge T = R \wedge q$$

which when applied to equation (28) gives

$$d \wedge F + \omega \wedge F = A^{(0)}\, R \wedge q$$

and

$$d \wedge \tilde{F} + \omega \wedge \tilde{F} = A^{(0)}\, \tilde{R} \wedge q \tag{29}$$

for the Hodge dual. R is the Cartan curvature form.

In a flat spacetime, these reduce to

$$d \wedge F + \omega \wedge F = 0 \tag{30}$$

and

$$d \wedge \tilde{F} + \omega \wedge \tilde{F} = \frac{\tilde{J}}{\epsilon_0} \tag{31}$$

where $\tilde{J}$ is the current density and ϵ_0 is the permittivity of the medium.

These simplify to the ECE equations of electromagnetism,

$$\nabla \cdot \boldsymbol{B}^a = \rho_m \tag{32}$$

$$\nabla \times \boldsymbol{E}^a + \frac{\partial \boldsymbol{B}^a}{\partial t} = \boldsymbol{j}^a \tag{33}$$

$$\nabla \cdot \boldsymbol{E}^a = \frac{\rho^a}{\varepsilon_0} \tag{34}$$

$$\nabla \times \boldsymbol{B}^a - \frac{1}{c^2}\frac{\partial \boldsymbol{E}^a}{\partial t} = \mu_0 \boldsymbol{J}^a \quad . \tag{35}$$

$\boldsymbol{B}^a$ is the magnetic induction, $\boldsymbol{E}^a$ is the electric intensity, ρ_m is the magnetic charge density, $\boldsymbol{j}^a$ is the magnetic current density, ρ^a is the electric charge density, $\boldsymbol{J}^a$ is the electric current density and c is the speed of light in the medium. It is assumed in this discussion that the permittivity ϵ_0 and permeability μ_0 are that of the vacuum in order to keep the mathematics the simplest.

To see how the fundamental forms for the electric and magnetic fields arise, we use the fundamental rule of Cartan Geometry

$$\omega^a_{\mu\nu} = \omega^a_{\mu b} q^b_\nu \ . \tag{36}$$

The electromagnetic field tensor becomes

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu + \omega_{\mu b} A^b_\nu - \omega_{\nu b} A^b_\mu \tag{37}$$

where ω is the spin connection and A is the electromagnetic potential.

Expressing this in the more traditional coordinates used in the physical sciences and engineering, this equation becomes

$$\boldsymbol{E}^a = (-\nabla \phi^a - \frac{\partial \boldsymbol{A}^a}{\partial t}) + (\boldsymbol{\omega}^a \phi^a - \omega^a_0 \boldsymbol{A}^a) \tag{38}$$

$$\boldsymbol{B}^a = (\nabla \times \boldsymbol{A}^a) - (\boldsymbol{\omega}^a \times \boldsymbol{A}^a) \tag{39}$$

where grouping has been done to illustrate the traditional portions of the fields, and those due to the spin connection

The antisymmetry constraint, a result of mathematics only, becomes in this representation,

$$\frac{\partial \boldsymbol{A}^a}{\partial t} - \nabla \phi^a + \omega^a_0 \boldsymbol{A}^a + \boldsymbol{\omega}^a \phi^a = 0 \tag{40}$$

$$\frac{\partial A^a_i}{\partial x_j} + \frac{\partial A^a_j}{\partial x_i} + \omega^a_i A^a_j + \omega^a_j A^a_i = 0 \quad . \tag{41}$$

For static electromagnetism, for the case of a single polarization, the electric intensity in ECE theory (38) reduces to [1]

$$\boldsymbol{E} = -\boldsymbol{\nabla}\phi - \omega_0 \boldsymbol{A} + \boldsymbol{\omega}\phi \quad . \tag{42}$$

The magnetic induction becomes [1]

$$\boldsymbol{B} = \boldsymbol{\nabla} \times \boldsymbol{A} - \boldsymbol{\omega} \times \boldsymbol{A} \quad . \tag{43}$$

The antisymmetry equations given earlier, equations (40) and (41), reduce to two sets of equations. The electric antisymmetry equation for static fields [13] is

$$-\boldsymbol{\nabla}\phi + \omega_0 \boldsymbol{A} + \boldsymbol{\omega}\phi = 0 \tag{44}$$

and correspondingly, the magnetic antisymmetry equation for static fields [13] is

$$\frac{\partial A_k}{\partial x_j} + \frac{\partial A_j}{\partial x_k} + \omega_j A_k + \omega_k A_j = 0 \tag{45}$$

where the Einstein convention of summation over repeated indices is not implied. $\boldsymbol{E}$ is the electric intensity, $\boldsymbol{B}$ is the magnetic induction, $\boldsymbol{A}$ is the magnetic vector potential, ϕ is the electric scalar potential, $\boldsymbol{\omega}$ is the vector spin connection and ω_o is the scalar spin connection.

The electric intensity as given by equation (42) becomes when equation (44) is applied [3],

$$\boldsymbol{E} = -2\boldsymbol{\nabla}\phi + 2\boldsymbol{\omega}\phi \quad . \tag{46}$$

If one neglects the possibility of magnetic charges, a set of equations identical in form only to Maxwell's equations emerge from ECE theory. The static field equations for ECE electromagnetism are [2]

$$\boldsymbol{\nabla} \cdot \boldsymbol{B} = 0 \tag{47}$$

$$\boldsymbol{\nabla} \times \boldsymbol{E} = 0 \tag{48}$$

$$\boldsymbol{\nabla} \cdot \boldsymbol{E} = \frac{\rho}{\epsilon_0} \tag{49}$$

$$\boldsymbol{\nabla} \times \boldsymbol{B} = \mu_0 \boldsymbol{J} \quad . \tag{50}$$

For the purposes of this discussion, we shall consider the Coulomb Law to be of primary importance which is given by equations (46) and (49) as

$$-\nabla^2\phi + \boldsymbol{\nabla} \cdot (\boldsymbol{\omega}\phi) = \frac{\rho}{2\epsilon_0} \tag{51}$$

or upon expanding the divergence term,

$$-\nabla^2\phi + \boldsymbol{\nabla}\phi\cdot\boldsymbol{\omega} + \phi\boldsymbol{\nabla}\cdot\boldsymbol{\omega} = \frac{\rho}{2\epsilon_0} \quad . \tag{52}$$

This is the resonant Coulomb equation discussed elsewhere [14], corrected for the effects of antisymmetry.

As a first model of the classical hydrogen atom, consider a positive point charge surrounded with a sheath of negative charge at the Bohr radius. A typical classical value, if the Bohr radius is taken as unity, is a proton radius of about 10^{-5} times the size of the Bohr radius. This suggests that the point source model is valid for the core.

If we assume spherical symmetry with radial dependence only, the vector spin connection $\boldsymbol{\omega}$ takes the form

$$\boldsymbol{\omega}(r) = (\omega_r(r), 0, 0)^T. \tag{53}$$

Substituting (53) into the Coulomb equation (52), we are left with an underspecified system given by

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\phi}{\partial r}\right) - \omega_r\frac{\partial\phi}{\partial r} - \phi\cdot\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\omega_r\right) = -\frac{\rho}{2\epsilon_0} \quad . \tag{54}$$

Coulomb's Law has been verified experimentally to a high degree of accuracy in regions some distance away from a charged region. We will regard the field far away from the orbiting electron in the hydrogen atom to be of the traditional form. Therefore the solution ϕ of ECE theory has to correspond to the classical solution $\phi_{classical}$ of the Poisson equation

$$\Delta\phi_{classical} = -\frac{\rho}{\epsilon_0} \tag{55}$$

in that region. In case of the hydrogen atom there is an electronic charge density ρ which contributes to the total atomic potential which complicates the analysis and is given by

$$\phi_H = \phi_{core} + \phi_{electron} \tag{56}$$

with

$$\phi_{core} = -\frac{q}{4\pi\epsilon_0 r} \tag{57}$$

and

$$\phi_{electron} = \frac{1}{4\pi\epsilon_0}\int\frac{\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}d^3r'. \tag{58}$$

The charge density in equation (58) is known analytically [15] for the hydrogen orbitals. For example we have for the 1s state

$$\rho_{1s} = \frac{1}{\pi}\left(\frac{1}{a_0}\right)^3 \exp\left(-\frac{2r}{a_0}\right) \quad . \tag{59}$$

Therefore equation (58) can be evaluated analytically or numerically and ϕ_H is known. With this knowledge, ϕ_H and ρ can be inserted into Eq. (54), giving an equation for the spin connection ω_r:

$$\frac{\partial^2 \phi_H}{\partial r^2} + \left(\frac{2}{r} - \omega_r\right)\frac{\partial \phi_H}{\partial r} - \phi_H \cdot \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\,\omega_r\right) = -\frac{\rho}{2\epsilon_0} \tag{60}$$

or upon expanding

$$\frac{\partial^2 \phi_H}{\partial r^2} + \left(\frac{2}{r} - \omega_r\right)\frac{\partial \phi_H}{\partial r} - \phi_H \cdot \frac{2}{r}\,\omega_r - \phi_H \cdot \frac{\partial \omega_r}{\partial r} = -\frac{\rho}{2\epsilon_0} \, . \tag{61}$$

This equation has been solved for ω_r. The spin connection is then

$$\omega_r = -\frac{1}{2r} - \frac{1}{a_0} + \frac{1}{2a_0\left(1+\frac{r}{a_0}\right)} \quad . \tag{62}$$

In [14] the choice $-\,1\,/\,r$ for ω_r was made solely for the Coulomb potential of the nucleus. The improved solution (62) includes the electron density and is of higher order in this respect.

We now look for resonance effects or other anomalies introduced by this formulation. Equation (54) is a second order differential equation in ϕ with non-constant coefficients. If the coefficients were constant, a driving force

$$\rho = \rho_0 \cos\left(\kappa r\right) \tag{63}$$

added to the atomic charge density would give a Bernoulli resonance when the wave number κ approaches the Eigen frequency. In the case of equation (54) the situation is more complicated. Earlier investigations [14] have shown that resonance is indeed possible. The atomic energy levels are either lowered dramatically or lifted up very near to the free particle limit of the electron. Then dissociating of an electron from the atom could be easy and may produce excessive current densities in macroscopic applications.

To expand on this concept, we use recent studies [17,18] that have shown that force laws can be derived from the space-time metric and the tetrad *q*, discussed earlier. The Coulomb and gravitational force vary as $1\,/\,r^2$ and can be described by

$$F = -\frac{\partial \phi}{\partial r} = -\frac{1}{2} m c^2 \frac{r_0}{r^2} \tag{64}$$

where *m* is the mass of a test body, *c* is vacuum speed of light and r_0 is a constant. For Coulomb's law this is

$$r_0 = \frac{2q_1q_2}{4\pi m\varepsilon_0 c^2} \tag{65}$$

with q_1 and q_2 being the charges of the central mass and the test mass. The equation of motion is

$$m\ddot{r} = F$$

which describes the motion of a mass *m* in the Coulomb field. In order to evoke a resonance, a restoring force in proportion to r has to be present:

$$m\ddot{r} + kr = F \tag{66}$$

and the external force *F*, coming from the metric, has to be of the form

$$F = F_0 \cos{(\omega t)}. \tag{67}$$

The connection with the metric requires validity of equation (64) so we obtain for the parameter r_0 in this case

$$r_0 = -\frac{2r^2}{mc^2} \quad F_0 \cos{(\omega t)}. \tag{68}$$

Because of equation (64) and (65) this corresponds to a "driving potential" ϕ_D of the driving force with

$$F = F_0 \cos(\omega t) = -\frac{\partial \phi_D}{\partial r} \quad . \tag{69}$$

This equation integrated by r gives the form of the time-modulated driving potential

$$\phi_D = -F_0 r \cos(\omega t). \tag{70}$$

Note that we are using a spherical coordinate system. Therefore this corresponds to a potential rising linearly in radial direction from the center. It has to be cut at an end radius where a surface charge of the sphere can be assumed to balance the central charge. In case of hydrogen this can be considered as an ionized state with the valence electron stripped off. Then the central charge is the proton charge which is shielded by a "vacuum polarization charge" at the surface of the hypothetical sphere. The effect of vacuum polarization is well known experimentally and described elsewhere [19].

To apply equation (70) to the case of the hydrogen atom we have to convert the time oscillation into a space oscillation with wave number κ. By considering the cut off point discussed above corresponding to the wavelength (or multiple) of the driving potential, we have

$$\phi_D = -F_0 r \cos(\kappa r). \tag{71}$$

This is an expression for the driving term in Eq. (66). To this we add a restoring force term

$$F_R = kr = -\frac{\partial \phi_R}{\partial r} \tag{72}$$

which gives

$$\phi_R = -\frac{1}{2}kr^2 \tag{73}$$

and is an harmonic oscillator potential. For resonance, we should use for the total potential:

$$\phi = \phi_{core} + \phi_R + \phi_D + \phi_{electron} \tag{74}$$

where $\phi_{electron}$ is unknown.

Normally an equation of motion would have to be solved to let resonances appear. We now compute the electron potential from ϕ with the given spin connection ω_r from equation (62), equation (54) and the above potentials.

At this point in the development of the theory, the value for the "restoring coefficient" is unknown. It is related intimately to the structure of space-time, but its value is yet to be determined. The nature of the solution can still be determined however.

For example, if one considers the situation where the driving potential is cut-off say at the first Bohr orbit, then the nature of the solution varies with the wavenumber of the driving potential. Illustrated in Figure 1 is the situation where the driving potential has wavenumbers *0, π,* and *2π.* Depending on the nature of the wavenumber, be it even or odd, one of two solutions types result. With the wavenumber an odd multiple of π the potential well of the electron is shifted towards the core. With an even number wave number, multiple wells exist, one of them at the Bohr orbit.

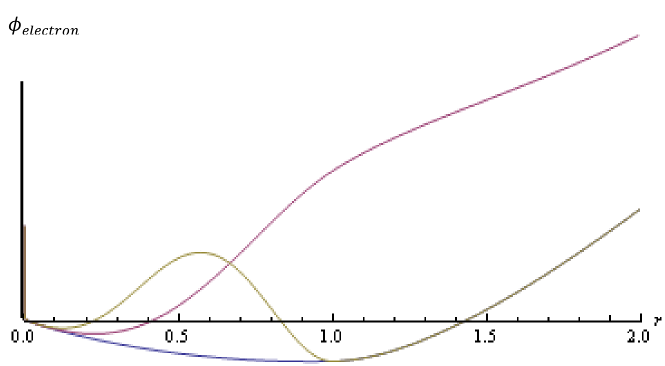

Figure 1. $\phi_{electron}$ for resonant equation with $\kappa = 0, \pi, 2\pi$

For example with the wavenumber $\kappa = 4\pi$, multiple wells occur, as shown in Figure 2. The number of wells increases with increasing wavenumber, all inside the cut off radius.

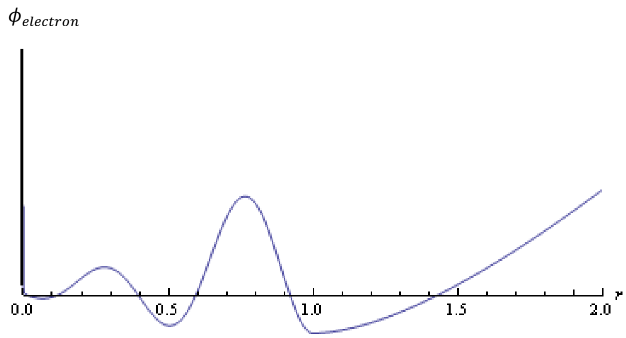

Figure 2. $\phi_{electron}$ for resonant equation with $\kappa = 4\pi$

Variation in the restoring coefficient also has significant influence on the form of the solution as illustrated in Figures 3 and 4.

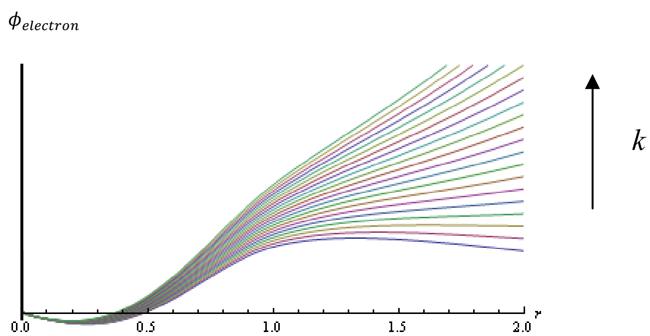

Figure 3. $\phi_{electron}$ for resonant equation with increasing *k;* $\kappa = \pi$

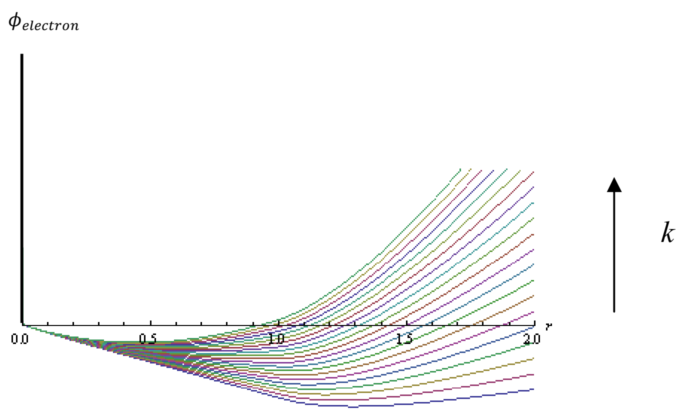

Figure 4. $\phi_{electron}$ for resonant equation with increasing *k;* $\kappa = 0$

If one reverses the sign of the driving potential, the potential again changes, strengthening the potential well about the electron, and not creating any new wells. (See Figure 5)

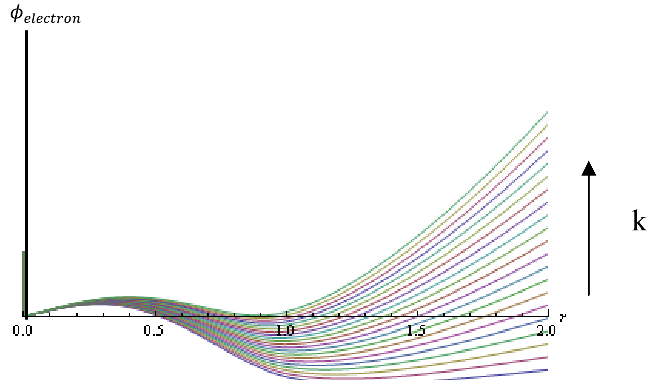

Figure 5. $\phi_{electron}$ for resonant equation with increasing k; $\kappa = \pi$, reversed driving potential

As was mentioned earlier, at this point, the values for the magnitudes of the driving and restoring potentials and value for the wave number for the driving potential is unknown. Resonances were observed over a large range for these. It is important to note, that although the driving potential was cut off at the first Bohr orbit, it had serious consequences beyond this radial position, to the point of destroying the classical $1 / r$ potential for large distances away from the atom. Until the value of the restoring coefficient is determined, this remains a vague area.

Future work, expanding upon this model, would be to take the calculated spin connections and substitute them into the ECE Coulomb equation to get a new potential function. Substituting of this into Schrodinger's equation would give a new charge density, which could be used to calculate a new potential, given the spin connection already calculated. This process could be repeated in principle until convergence is achieved.

On a second front, further work remains to be done on determining the spacetime values for the resonant potentials. This would allow a quantitative determination of the resonant effects due to the restoring effect of spacetime.

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