THE m THEORY OF ELEMENTARY PARTICLES.

by

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ABSTRACT

The m theory is applied to the interaction of two particles such as a neutron and proton inside the nucleus. The strong nuclear force is identified with the m force generated by space itself. Well known model forces such as the Yukawa force are found to be special cases of the m force. Particles such as pions and quarks are inferred to be manifestations of space itself, the m space being the most general spherically symmetric space.

Keywords: ECE unified field theory, m theory, elementary particles.

4FT 432

1. INTRODUCTION

In recent papers of this series {1 - 41} the m theory has been applied to low energy nuclear reactions (LENR) by identifying the strong nuclear force with the m force introduced in UFT417 using Euler Lagrange dynamics and confirmed in UFT427 using Hamilton dynamics. In Section 2 the m theory is applied to elementary particle theory in order to eliminate procedures such as renormalization, regularization, asymptotic freedom, and quark confinement. In m theory particles such as pions and quarks become manifestation of m space itself within the context of the well known ECE generally covariant unified field theory. In Section 3 the results of Section 2 are developed and graphed.

This paper is a short synopsis of extensive and detailed calculations found in the notes accompanying UFT432 on www.aias.us . Note 432(1) the well known Yukawa model of the strong force is shown to be a limit of the m force. Note 432(2) develops the interaction between two particles in terms of their additive m forces, so any Coulombic interaction for example is always accompanied by an additive m force. Note 432(3) develops the interaction of a proton with the Born Lande lattice, and gives an indication of the conditions under which LENR can occur in a lattice immersed in hydrogen gas. Notes 432(4) and 432(5) develop the semi classical theory of particle interaction via the strong nuclear force, the pions being developed via the minimal prescription. It is shown that a rich mass spectrum results on the semi classical level, for example pion and quark masses are manifestations of m space, the most general spherically symmetric space.

2. THE m THEORY APPLIED TO PARTICLE PHYSICS.

The interaction between the proton and neutron in particle physics is modelled by various means, the most well known being the Yukawa potential and force of 1935, which inferred the existence of the meson, later recognized to be three pions. In the (r_1 , ϕ)

frame of m theory the Yukawa potential (Note 432(1)) is given by:

$$U(r) = -g^2 \frac{m^{1/2}(r)}{r} \exp\left(\frac{-\mu r}{m^{1/2}(r)} \right) \quad -(1)$$

where m (r) is the m function introduced in recent UFT papers and where g and μ are the well known parameters of the Yukawa potential. In this section the empirical Yukawa force is recognized to be a limit of m theory, in which the force magnitude is:

$$F = -\frac{dm(r)}{dr} \left(\frac{m(r)^{1/2}}{2m(r) - r\frac{dm(r)}{dr}} \right) E \quad -(2)$$

where:

$$E^2 = p^2c^2 + m(r)m^2c^4 . \quad -(3)$$

The force magnitude in Eq. (2) is that of the most general spherically symmetric space defined by the infinitesimal line element:

$$ds^2 = c^2 d\tau^2 = m(r)c^2 dt^2 - \frac{dr^2}{m(r)} - r^2 d\phi^2 \quad -(4)$$

where τ is the proper time. In these equations $\underline{p}$ is the relativistic momentum. When considering the interaction of two particles 1 and 2 the combined m force is:

$$F = -\sum_i \frac{dm_i(r)}{dr} \left(\frac{m_i(r)^{1/2}}{2m_i(r) - r\frac{dm_i(r)}{dr}} \right) E_i \quad -(5)$$

where

$$E_i^2 = p_i^2c^2 + m_i(r)m_i^2c^4 \quad -(6)$$

and

$$E_i = \gamma_i m_i(r) m_i c^2 \quad -(7)$$

Here m_1 and m_2 can denote a proton and neutron or a proton and a metal nucleus. The energy sum is always positive but the sum of force components F_i is attractive if:

$$2m(r) > r\frac{dm(r)}{dr} \quad -(8)$$

and repulsive if

$$2m(r) < r\frac{dm(r)}{dr} \quad -(9)$$

Under condition (8) the attractive force approaches negative infinity as 2m (r) approaches $r\,dm(r)/dr$. Under condition (9) the repulsive force approaches positive infinity as 2m (r) approaches $dm(r)/dr$.

For example the Coulomb repulsion in m space between a proton p and a nucleus is:

$$F_c = \frac{m(r) Z_1 Z_2}{4\pi \epsilon_0 r^2} \quad -(10)$$

in m theory as in UFT417 ff. Here Z_1 and Z_2 are the atomic numbers of p and ^{64}Ni and ϵ_0 is the vacuum permittivity. The total force of interaction is therefore:

$$F = F_1 + F_2 + F_c \quad -(11)$$

and under the condition:

$$2m(r) = r\frac{dm(r)}{dr} \quad -(12)$$

the total force of interaction can approach negative infinity and overcome the Coulomb barrier. Under these conditions LENR occurs, p enters the ^{64}Ni nucleus and the combined entity disintegrates to ^{63}Cu, reaction products and energy in the form of heat and visible frequency radiation.

If the nucleus is modelled as a sphere of radius R, the total force (11) is defined by:

$$r \geq R. \quad -(13)$$

Once the $p\,^{64}Ni$ complex is formed, the Coulombic repulsive potential is replaced by:

$$U_c = \frac{1}{2}\frac{Z_1 Z_2 e^2}{4\pi\epsilon_0 R}\left(3 - \frac{1}{m(r)}\left(\frac{r}{R}\right)^2\right). \quad -(14)$$

The force from Eq. (14) is:

$$F_c = -\frac{\partial U_c}{\partial r} = \frac{1}{2}\frac{Z_1 Z_2 e^2 r}{R^3 m(r)^2}\left(2m(r) - r\frac{dm(r)}{dr}\right) \quad -(15)$$

and the total force inside the $p\,^{64}Ni$ complex is:

$$F = F_1 + F_2 + F_c. \quad -(16)$$

If this is positive the complex transmutes into ^{63}Cu, energy and other products. There is a mass loss which is equivalent to the release of energy:

$$\Delta E = \Delta m c^2 \quad -(17)$$

in the form of heat and visible frequency radiation, but no gamma rays.

The emitted radiation is found to be in the visible to ultra violet range of emission by nickel vapour:

$$\omega = (2.938 \text{ to } 4.838) \times 10^{15} \text{ rad s}^{-1}. \quad -(18)$$

The mass loss due to this emission is:

$$\Delta m = \frac{\hbar\omega}{c^2} = 5.23 \times 10^{-35} \text{ kg}. \quad -(19)$$

When ^{64}Ni transmutes into ^{63}Cu it loses one proton of mass:

$$m_p = 1.67265 \times 10^{-27} \text{ kg} \quad -(20)$$

so only a very small amount of ^{64}Ni is transmuted into ^{63}Cu, which is why only traces of ^{63}Cu are found experimentally. The percentage of ^{64}Ni transmuted to ^{63}Cu is

$$x = \frac{5.23 \times 10^{-35}}{1.67265 \times 10^{-27}} \times 100\% \quad -(21)$$
$$= 3.13 \times 10^{-6}\ \%$$

If all the nickel transmuted to copper the angular frequency of the emitted radiation would be:

$$\omega = \frac{m_p c^2}{\hbar} = 1.427 \times 10^{24} \text{ rad s}^{-1} \quad -(22)$$

which corresponds to extremely harmful hard gamma rays. These gamma rays are not observed experimentally.

It is also known that LENR takes place only if conditions are engineered with great care. Note 432(3) develops the conditions under which a Born Landé lattice immersed in hydrogen gas (protons) leads to a LENR reaction when the proton enters the lattice.

The m theory gives a straightforward explanation of the interaction between a proton and neutron mediated by pions. This explanation is based on the de Broglie / Einstein equation for total relativistic energy of the pion in m space:

$$E = \gamma m(r) mc^2 = \hbar\omega \quad -(23)$$

where γ is the generalized Lorentz factor of m theory introduced in UFT415 ff. Eq. (23) can be expressed as:

$$E^2 = p^2c^2 + m(r) m^2 c^4 = \hbar^2\omega^2 \quad -(24)$$

Using the wave particle dualism of the relativistic momentum:

$$\underline{p} = \hbar \underline{\kappa} \quad -(25)$$

then

$$E^2 = \hbar^2 c^2 \kappa^2 + m(r) m^2 c^4 = \hbar^2\omega^2. \quad -(26)$$

The pion travels close to c so:

$$\omega \sim c\kappa \quad -(27)$$

and

$$E = m(r)^{1/2} mc^2 = \hbar\omega = 2\pi\hbar f = \frac{2\pi\hbar}{t} \quad -(28)$$

where f is frequency and t is time. The distance travelled by the pion in time t is:

$$d = ct \quad -(29)$$

so

$$E = \frac{hc}{d} = \frac{2\pi\hbar c}{d} \quad -(30)$$

This energy corresponds to a pion mass of:

$$m = \frac{E}{m(r)^{1/2} c^2} \quad -(31)$$

In m theory the pion is a real particle that is observed in cosmic ray experiments. Experiments show that there are three pions with different energies and masses.

Yukawa's original calculation of 1935 assumed the validity of the Heisenberg uncertainty principle, which was thoroughly refuted in UFT175, now a classic and one of the most studied of the UFT papers. Furthermore, Yukawa made the unfounded assumption that conservation of mass energy is violated for a time:

$$\Delta t \sim \frac{h}{4\pi \Delta E} \quad -(32)$$

and made another non Baconian assumption that no process can detect this violation. Finally he calculated the mass of the pion from:

$$d = c\Delta t. \quad -(33)$$

In the standard dogma used by Yukawa the pion is not directly observable, its range is limited by the fact that it can exist for only a short time, determined by the Heisenberg principle of indeterminacy, which asserts that certain things are absolutely unknowable. The Einstein / de Broglie / Vigier School immediately rejected this idea as random subjectivity. So the pion is called a virtual particle. Unfortunately these severely non Baconian ideas have come to permeate physics, so that the interaction between two electrons for example is mediated by a virtual photon, and the interaction between two quarks by a virtual gluon. Furthermore, the standard dogma confines quarks so that no free quarks can be observed. In Pauli's dictum, quarks are not even wrong, meaning that they cannot be observed and violate Baconian principles.

All this dogma is swept aside in m theory.

The standard dogma can be replaced by a semi classical theory as shown in Note 432(5). This is based on the minimal prescription:

$$E \rightarrow E - U \quad -(34)$$

$$\underline{p} \rightarrow \underline{p} - \underline{q} \quad -(35)$$

where U is the potential energy of interaction between a proton and a neutron and $\underline{q}$ is the momentum of the classical force field between the neutron and the proton. The classical force field quantizes into real pions and not virtual pions. The Schroedinger equation governing the semi classical theory is:

$$(H_1 + H_2 + H_3)\psi = E\psi \quad -(36)$$

where:

$$H_1 = mc^2 + U \quad -(37)$$

$$H_2 = \frac{1}{2m}\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - \underline{q})\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - \underline{q}) \quad -(38)$$

$$H_3 = \frac{1}{2m}\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - \underline{q})U\underline{\sigma}\cdot(-i\hbar\underline{\nabla} - \underline{q}) \quad -(39)$$

The structure of these equations exactly parallels the semi classical Dirac theory of the interaction of the electron with the electromagnetic field. One electron acts as a transmitter and the other as a receiver, and the field of force is the electromagnetic field which quantizes to real photons, not virtual photons.

On this semi classical level the proton is the transmitter of the classical strong field and the neutron is the receiver. In m theory the strong force exists if and only if:

$$\frac{dm(r)}{dr} \neq 0, \quad m(r) \neq 0 \quad -(40)$$

so the relevant hamiltonian is that of relativistic quantum m theory, Eq. (47) of UFT428:

$$H = m(r)^{1/2}\left(mc^2 + U\right) + H_1 + H_2 + H_3 + H_4 \quad -(41)$$

where:

$$H_1 = \frac{1}{2m}\,\underline{\sigma}\cdot\underline{p}\,\frac{1}{m(r)^{1/2}}\,\underline{\sigma}\cdot\underline{p} \quad -(42)$$

$$H_2 = -\frac{1}{2m}\left(\underline{\sigma}\cdot\underline{q}\,\frac{1}{m(r)^{1/2}}\,\underline{\sigma}\cdot\underline{p} + \underline{\sigma}\cdot\underline{p}\,\frac{1}{m(r)^{1/2}}\,\underline{\sigma}\cdot\underline{q}\right) \quad -(43)$$

$$H_3 = \frac{1}{2m}\,\underline{\sigma}\cdot\underline{q}\,\frac{1}{m(r)^{1/2}}\,\underline{\sigma}\cdot\underline{q} \quad -(44)$$

$$H_4 = \frac{1}{2m}\,\underline{\sigma}\cdot(\underline{p}-\underline{q})\,\frac{U}{2mc^2\,m(r)^{1/2}}\,\underline{\sigma}\cdot(\underline{p}-\underline{q}). \quad -(45)$$

The classical scalar potential U of the strong force is defined by:

$$F = -\frac{\partial U}{\partial r} \quad -(46)$$

and the classical vector potential of the strong force is $\underline{q}$. Analogously, the classical scalar and vector potentials of the electromagnetic field are ϕ and $\underline{A}$.

The classical energy of the strong field is:

$$E^2 = p^2c^2 + m(r)\,m^2c^4 \quad -(47)$$

where m is the classical mass of the strong field, analogous with electromagnetic mass.

In the Dirac approximation:

$$E = \frac{p^2}{2m(r)^{1/2}m} + m(r)^{1/2}mc^2 \quad -(48)$$

giving the energy expectation values:

$$\langle E \rangle = -\frac{\hbar^2}{2m}\int \phi^* \nabla^2 \left(\frac{\phi}{m(r)^{1/2}}\right) d\tau + mc^2 \int \phi^* m(r)^{1/2} \phi \, d\tau. \quad -(49)$$

These expectation values give the three pion energy levels. The three pion masses are given finally by:

$$m = \frac{E}{c^2} \quad -(50)$$

giving the mass spectrum of real pions.

From Eq. (42), in which m refers to the proton, the energy levels on quantization are given by:

$$E = \langle H_1 \rangle = -\frac{\hbar^2}{2m}\int \underline{\sigma} \cdot \underline{\nabla} \left(\frac{1}{m(r)^{1/2}} \underline{\sigma} \cdot \underline{\nabla} \phi\right) d\tau \quad -(51)$$

giving the mass spectrum of the quantized proton. In the standard model these are asserted to be three quarks held together by virtual gluons, the quanta of the strong force. The strong nuclear force between proton and neutron is asserted in the standard dogma to be a residual of the strong force between quarks. In the standard model both virtual gluons and virtual quarks are unobservable. In m theory all this dogma is swept aside and replaced by m functions.

The m theory of elementary particles

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3 Numerical computation and discussion

3.1 Yukawa and Coulomb force

We compare the Yukawa and Coulomb force of m theory. First we explain and recapitulate how any calculation for m theory has to take place. Transformation from (r, ϕ) space to (r_1, ϕ) space (shortly noted r and r_1 space) takes place via the coordinate transformation

$$r_1 = \frac{r}{\mathrm{m}(r)^{1/2}}. \tag{52}$$

The procedure of doing computations within m theory is graphically presented in Fig. 1. As an example we take the force computation from a potential in m theory. First we have to translate the original problem, here the Yukawa potential, to m space by replacing the r coordinate by the r_1 coordinate:

$$U_Y(r) = -g^2 \frac{\exp(-\mu r)}{r} \tag{53}$$

$$\downarrow$$

$$U_{Y1}(r_1) = -g^2 \frac{\exp(-\mu r_1)}{r_1}. \tag{54}$$

g and μ are suitable factors adopted to the particular nucleus. We can now re-transform this expression to r space by applying (52):

$$U_{Y1}(r) = -g^2 \frac{\mathrm{m}(r)^{1/2}}{r} \exp\left(\frac{-\mu r}{\mathrm{m}(r)^{1/2}}\right). \tag{55}$$

The Yukawa potential will appear to an external observer in coordinate space r in this form. Computing the Yukawa force of m theory has to take place in r_1

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space:

$$F_{Y1}(r_1) = -\frac{\partial U_{Y1}(r_1)}{\partial r_1} \tag{56}$$
$$= -\frac{g^2}{{r_1}^2}\left(\mu r_1 + 1\right)\exp(-\mu r_1)$$

and this expression can be re-transformed to the observer space in the same way as the potential, giving

$$F_{Y1}(r) = -\frac{g^2 \mathrm{m}(r)}{r^2}\left(\mu \frac{r}{\mathrm{m}(r)^{1/2}} + 1\right)\exp\left(-\mu \frac{r}{\mathrm{m}(r)^{1/2}}\right). \tag{57}$$

For LENR processes this force has to be compared with the Coulomb force which should be compensated by the Yukawa force. Applying the same procedure of Fig. 1 with the Coulomb potential

$$U_C(r) = -\frac{Z_1 Z_2 e^2}{4\pi\epsilon_0 r} \tag{58}$$

leads to the results

$$U_{C1}(r) = -\frac{Z_1 Z_2 e^2 \mathrm{m}(r)^{1/2}}{4\pi\epsilon_0 r}, \tag{59}$$

$$F_{C1}(r_1) = -\frac{Z_1 Z_2 e^2}{4\pi\epsilon_0 r_1^2} \tag{60}$$

in r and r_1 space and to

$$F_C(r) = -\frac{Z_1 Z_2 e^2 \mathrm{m}(r)}{4\pi\epsilon_0 r^2} \tag{61}$$

in r space where Z_1 and Z_2 are the charge numbers of the involved particles and e is the elementary charge.

There is another path of calculation shown in Fig. 1 by the red arrow: The physical computation from U_1 to F_1 is performed in r space, i.e. using the r coordinate. We stress that this is a wrong application of the method. Computations have to take place in r_1 space exclusively and only the results are transformed back to obtain values of measurable quantities in r space.

Examples of the Yukawa and Coulomb potential are graphed in Fig. 2. We used the case of a proton approaching a ^{28}Ni nucleus with parameters $Z_1 = 28$, $Z_2 = 1$, $g = \sqrt{28}$ and $\mu = r_{\mathrm{Ni}}$, the nuclear radius of Ni. Results are given in atomic units. Index 0 refers to the ordinary potentials (53) and (58), while index 2 refers to their m space counterparts (55) and (59). The exponential m function of previous papers was used. It can be seen that m theory shifts the potenital significantly to smaller radii. The nucleus appears smaller than it would in flat space. Both potentials cancel out quite well.

In Fig. 3 the Yukawa and Coulomb force are graphed, computed after Eqs.(57) and (61) (named by index 1). In addition, the forces of m theory were evaluated in r space according to the incorrect method (see red line in Fig. 1). This leads to different expressions. These results are named by index 2 in Fig. 3. The curves are similar but visibly different. The differences between both methods are presented separately in Fig. 4. They are quite similar but opposite in sign for the Yukawa and Coulomb force. The curves are symmetric to zero, indicating that the difference in computation works similar in both cases. The Yukawa force cancels out the Coulomb force quite precisely.

3.2 m(r) derived from Born-Landé lattice

From experimental work it is asserted that the Hydrogen nuclei (protons) have to come near to the Ni nuclei to provoke the LENR reaction. We describe a computational method on basis of the so-called Born-Landé lattice. This is a historic method for computing the binding energies in ionic crystals. The potential energy in such a lattice is described by

$$U(r) = -\frac{Z_1 Z_2 e^2 M}{4\pi\epsilon_0 r} + \frac{B}{r^n} \tag{62}$$

where M is the so-called Madelung constant, containing the ionic energy contributions from neighboring atoms which are considered as charged spheres. The term B/r^n is a repulsive contribution. In the original Born-Landé theory the potential is computed for a fixed ionic distance r. Here we consider r as the radial variable, obtaining an expression for the potential energy around the Ni nucleus in the lattice. We neglect the repulsive part. We transform (62) to r_1 space, compute the force and re-transform to r space as done in the preceding section. The result of m theory then is

$$F_1(r_1) = -\frac{Z_1 Z_2 e^2 M}{4\pi\epsilon_0 r_1^2} \tag{63}$$

or, with the backtransformation from (52),

$$F_1(r) = -\frac{Z_1 Z_2 e^2 M}{4\pi\epsilon_0} \frac{\mathrm{m}(r)}{r^2}. \tag{64}$$

In order to outweight this Coulombic force, we equate this force with an attractive force as we did for the Yukawa case above. We choose the spacetime force of m theory derived in UFT 427:

$$F_2(r_1) = -\frac{E}{2\mathrm{m}(r_1)} \frac{d\mathrm{m}(r_1)}{dr_1}. \tag{65}$$

For re-transformation to r space we use

$$\frac{dm(r_1)}{dr_1} = \frac{dm(r)}{dr} \frac{dr}{dr_1}, \tag{66}$$

$$\frac{dr_1}{dr} = \frac{1}{2\mathrm{m}(r)^{3/2}} \left(2\mathrm{m}(r) - r\frac{d\mathrm{m}(r)}{dr} \right), \tag{67}$$

which leads to

$$F_2(r) = -\frac{d\mathrm{m}(r)}{dr} \frac{\mathrm{m}(r)^{1/2}\, E}{2\mathrm{m}(r) - r\frac{d\mathrm{m}(r)}{dr}} \tag{68}$$

with

$$E = \mathrm{m}(r)^{1/2}\, m_p c^2 \tag{69}$$

where m_p is the proton mass. $F_2(r)$ resonantly increases if the denominator vanishes:

$$2\mathrm{m}(r) - r\frac{d\mathrm{m}(r)}{dr} \;\rightarrow\; 0. \tag{70}$$

Equating both forces, we obtain

$$F_1(r) = F_2(r) \tag{71}$$

which leads to the equation

$$\frac{A\,\mathrm{m}(r)}{r^2} = \frac{\mathrm{m}(r)\,\left(\frac{d}{dr}\,\mathrm{m}(r)\right)}{2\,\mathrm{m}(r) - r\,\left(\frac{d}{dr}\,\mathrm{m}(r)\right)} \tag{72}$$

with the constant

$$A = \frac{Z_1 Z_2 e^2 M}{4\pi\epsilon_0 m_p c^2}. \tag{73}$$

The equation can be rewritten to

$$A\left(2\,\mathrm{m}(r) - r\,\left(\frac{d}{dr}\,\mathrm{m}(r)\right)\right) = r^2\,\left(\frac{d}{dr}\,\mathrm{m}(r)\right), \tag{74}$$

which is a differential equation for $\mathrm{m}(r)$. There is an analytical solution, a rational function

$$\mathrm{m}(r) = \frac{C\,r^2}{r^2 + 2Ar + A^2}. \tag{75}$$

By setting the constant $C = 1$, we obtain the required limt

$$\lim_{r\to\infty} \mathrm{m}(r) = 1. \tag{76}$$

This function is graphed in Fig. 5, together with its derivative and the resonance denominator (70). Since no Madelung constant of NiH could be found in literature, we used the lattice values of NaCl instead: $M = 1.748$ with $Z_1 = 11$, $Z_2 = 17$. The resulting m function in Fig. 5 looks quite similar to our earlier exponential function approach. However, for $r \to 0$, there is a horizontal tangent. Correspondingly the derivative of $\mathrm{m}(r)$ falls to zero at this point. The resonance denominator (70) looks quite similar to $\mathrm{m}(r)$, showing that the m force goes to infinity for $r \to 0$, as does the Lattice force.

We have to state that the m function was computed from conditions which only hold outside the Ni nucleus. The form of $\mathrm{m}(r)$ for $r < r_{Ni}$ can only be considered as an extrapolation. However the result is quite consistent with our earlier assumptions for $\mathrm{m}(r)$, enhancing confidence in this approach.

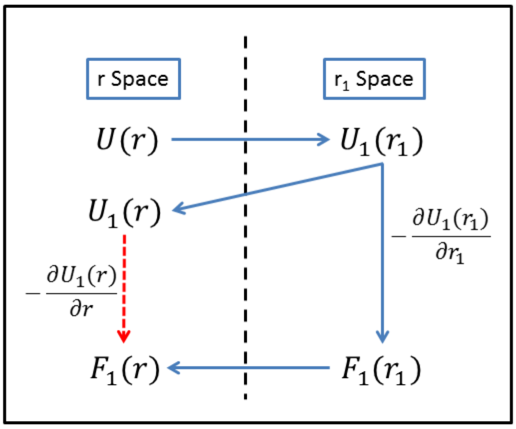

Figure 1: Calculation scheme for r_1 space.

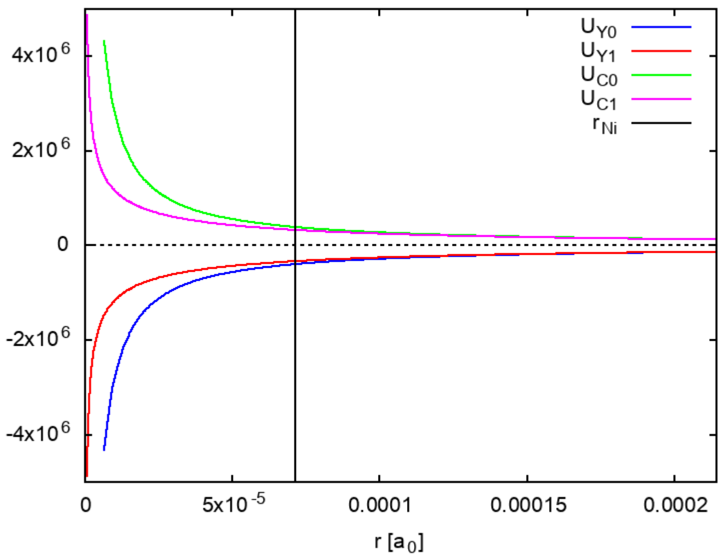

Figure 2: Yukawa and Coulomb potential in original form (53,58), index 0, and in m space (55,59), index 1.

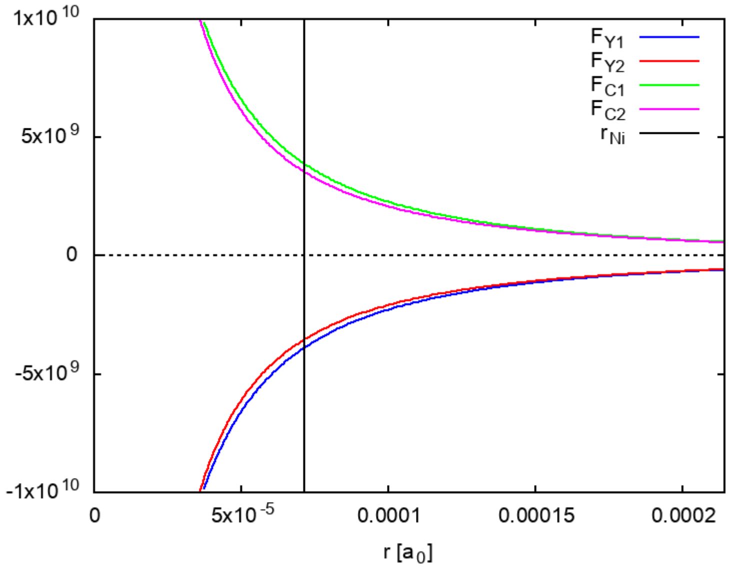

Figure 3: Yukawa and Coulomb force, alternatively computed. 1: correct method in r_1 space, 2: incorrect method in r space.

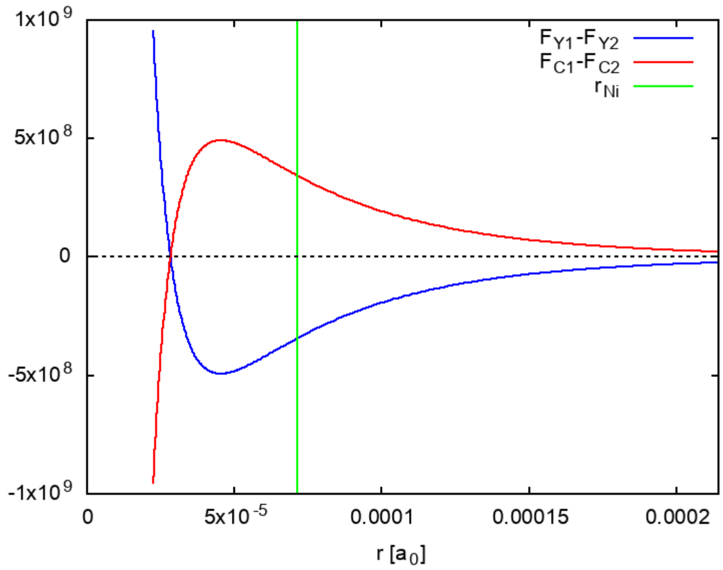

Figure 4: Difference between forces of both methods of Fig. 3.

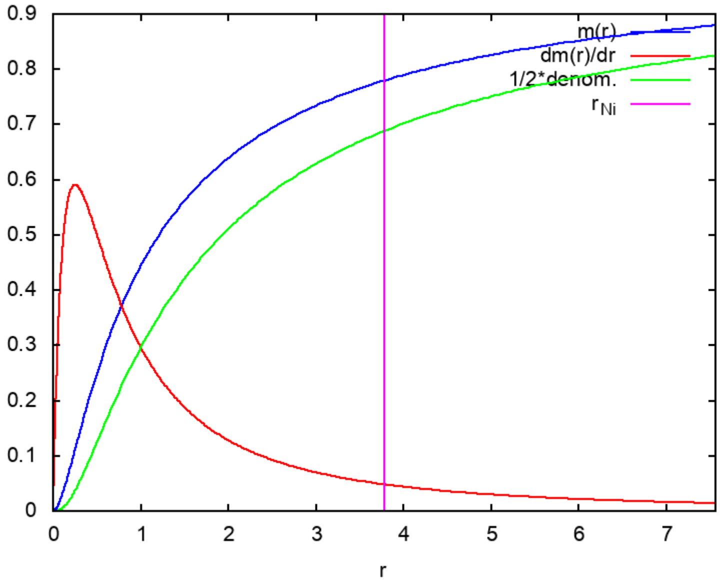

Figure 5: m(r), its derivative and resonance denominator from Born-Landé lattice.

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