# GENERAL m THEORY OF THE RADIATIVE CORRECTIONS.

by

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ABSTRACT

A new theory of all radiative corrections is developed, based on the characteristics of m space. The general theory describes: the g factor of the electron; the Lamb shift; the Casimir effect and vacuum polarization. The Casimir force and quantized Casimir force levels are defined for the H atom. All these well known radiative corrections are described with the relevant m space, characterized by a function m ( r ) and its r derivative. Therefore quantum electrodynamics and quantum chromodynamics are no longer required, and all their difficulties eliminated.

Keywords: ECE theory, general m theory of the radiative corrections.

4FT430

## 1. INTRODUCTION

In recent papers of this series {1 - 41} the m theory of the radiative corrections has been initiated. In standard physics the well known radiative corrections are described by quantum electrodynamics (QED) and quantum chromodynamics (QCD) using renormalization and regularization. These are arbitrary procedures described by Dirac as removing infinities with infinities to leave something finite behind. Feynman heavily criticized QED by an argument based on the Landau pole, and Ryder {1- 41} writes in "Quantum Field Theory" that there must be a better way of doing things. It is suggested in Section 2 that m theory is one method that is vastly superior to QED and QCD. Using m theory, the radiative corrections are described in terms of m space, the artificial need for renormalization, regularization and virtual particles is completely removed. In section 3, the results are computed and graphed, and a method suggested for extending m theory to elementary particle and nuclear physics.

This paper is a short synopsis of extensive calculations in the notes accompanying UFT430 on www.aias.us. Note 430(1) calculates the Lamb shift from m theory using the Dirac energy levels of the H atom. Note 430(2) calculates the Casimir force from theory and the Casimir shift in atomic hydrogen, a new concept. There should be a Casimir shift in all atoms and molecules. The classical Casimir force is calculated in Note 430(3). Note 430(4) summarizes the general m theory of the radiative corrections, and Note 430(5) gives the m theory of vacuum polarization.

## 2. m THEORY OF THE RADIATIVE CORRECTIONS

Consider firstly the m theory of the Lamb shift using the Dirac energy levels of the H atom {1 - 41}:

$$E_{nJ} = E_n\left(1+\left(\frac{\alpha}{n}\right)^2\left(\frac{n}{J+1/2}-\frac{3}{4}\right)\right) \quad -(1)$$

Here

$$E_n = -\frac{\mu e^4}{32\pi^2\epsilon_0^2\hbar^2 n^2} \quad -(2)$$

are the non relativistic energy levels. In this theory $\mu$ is the reduced mass of electron and proton, e is the charge on the proton, $\epsilon_0$ is the vacuum permittivity, $\hbar$ is the reduced Planck constant, n is the principal quantum number, J is the total angular momentum quantum number and $\alpha$ is the fine structure constant:

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c}. \quad -(3)$$

The quantum numbers obey the rules:

$$J = L \pm S = \frac{1}{2}, \frac{3}{2}, \ldots, n-\frac{1}{2} \quad -(4)$$

and

$$L = 0, \ldots, n-1, \quad -(5)$$

where S is the spin quantum number. As shown in UFT429, m theory predicts:

$$E_n = -\frac{\hbar^2}{2m}\int \psi^* \frac{1}{m(r)^{1/2}}\nabla^2\psi\, d\tau - \frac{\hbar^2}{2m}\int \psi^* \underline{\nabla}\left(\frac{1}{m(r)^{1/2}}\right)\cdot\underline{\nabla}\psi\, d\tau - \frac{e^2}{4\pi\epsilon_0}\int \psi^* \frac{m(r)^{1/2}}{r}\psi\, d\tau \quad -(6)$$

Using the non relativistic wave functions in the first approximation then Eq. (6) produces a Lamb shift which can be tuned precisely to the observed Lamb shift between

$2S^{1/2}$ and $2P^{1/2}$ in atomic H, Q. E. D.

In quantum electrodynamics (QED) the Lamb shift is expressed as a change in potential energy between $2S^{1/2}$ and $2P^{1/2}$. The energy level of $2S^{1/2}$ is increased but the energy level of $2P^{1/2}$ is not increased. So in QED the entire Lamb shift is attributed to an increase in potential energy:

$$\langle \Delta V \rangle = \frac{\alpha^5 mc^2}{6\pi} \log_e \left( \frac{1}{\pi\alpha} \right) \quad -(7)$$

due to zitterbewegung (electron shivering). This is further explained in Note 430(5). In m theory the Lamb shift is due to the m space itself and is calculated as in Eq. ( 6 ), and the m function found from precise experimental measurements of the Lamb shift. The m theory is preferred because it is far simpler and eliminates renormalization and regularization from quantum physics and quantum field theory.

In the Dirac theory:

$$E_{nJ}(2P^{1/2}) = E_{nJ}(2S^{1/2}) \quad -(8)$$

and there is no Lamb shift in the Dirac theory because:

$$2P_{1/2} : n = 1, L = 1, S = -1/2, J = 1/2 \quad -(9)$$

$$2S_{1/2} : n = 1, L = 0, S = 1/2, J = 1/2 \quad -(10)$$

and n and J are the same for $2P^{1/2}$ and $2S^{1/2}$. The m theory can also precisely explain the Lamb shifts between $3S_{1/2}$ and $3P_{1/2}$ and between $3P_{3/2}$ and $3D_{3/2}$. All these Lamb shifts are explained to any precision by tuning m $(r)$. This procedure removes the heavily criticized and ad hoc methods known as renormalization and regularization and can also be applied to quantum chromodynamics and nuclear and particle physics (See Section 3).

An m theory of the Casimir effect can be developed by considering the hamiltonian first defined in UFT428:

$$H = \frac{1}{m(r)^{1/2}} \frac{p^2}{2m} \left( 1 + \frac{U_0}{2mc^2} \right) + m(r)^{1/2} \left( U_0 + mc^2 \right). \quad -(11)$$

Here $\underline{p}$ is the linear momentum and m is the mass of an electron of the H atom. The potential energy of attraction between electron and proton is defined by:

$$U = m(r)^{1/2} U_0 \quad -(12)$$

where $U_0$ is the Coulombic potential energy:

$$U_0 = -\frac{e^2}{4\pi\epsilon_0 r}. \quad -(13)$$

In UFT427 it was shown that the force generated by m space is:

$$F = -\frac{mc^2}{2} \gamma \frac{\partial m(r_1)}{\partial r_1} = -\frac{E}{m(r_1)^{1/2}} \frac{\partial}{\partial r_1} \left( m^{1/2}(r_1) \right) \quad -(14)$$

where $\gamma$ is the generalized Lorentz factor of m theory and where

$$r_1 = \frac{r}{m(r)^{1/2}} \quad -(15)$$

defines the ( $r_1$, $\phi$ ) frame of reference. The relativistic total energy is:

$$E = \gamma m(r_1) mc^2 = m(r_1) \left( p_1^2 c^2 + m^2 c^4 \right)^{1/2} \quad -(16)$$

where the relativistic momentum in frame ( $r_1, \phi$ ) is

$$p_1 = \frac{p}{m(r)^{1/2}} \quad -(17)$$

It follows as in Note 430(2) that the force due to m space is:

$$F = -\frac{1}{2m(r_1)}\frac{\partial m(r_1)}{\partial r_1} E. \quad -(18)$$

Now use:

$$\frac{dm(r_1)}{dr_1} = \frac{dm(r)}{dr}\frac{dr}{dr_1} \quad -(19)$$

to find that

$$F = -\frac{dm(r)}{dr}\left(\frac{m(r)^{1/2}}{2m(r) - r\frac{dm(r)}{dr}}\right)E \quad -(20)$$

in frame ( r, $\phi$ ). This force goes to infinity under the condition:

$$2m(r) = r\frac{dm(r)}{dr} \quad -(21)$$

and was first discovered in UFT417.

Now define the Casimir force levels of the H atom as the expectation value:

$$\langle F \rangle = \langle f(r)E \rangle = -\frac{\hbar^2}{2m}\int \psi^* \nabla^2 \left(\frac{f(r)}{m(r)^{1/2}}\psi\right) d\tau,$$

$$f(r) := -\frac{dm(r)}{dr}\left(m(r)^{1/2}\left(2m(r) - r\frac{dm(r)}{dr}\right)^{-1}\right) \quad -(22)$$

So in addition to the Lamb shift there exists the Casimir shift and a spectrum of force levels. The force equation of quantum mechanics was introduced in UFT177. The Casimir force levels are computed in Section 3, initiating a new subject area of computational quantum mechanics. On the classical level the Casimir type force on an electron of momentum $\underline{p}$ and mass m is

$$F_0 = -\frac{dm(r)}{dr}\frac{p^2}{2m}\left(2m(r) - r\frac{dm(r)}{dr}\right)^{-1} \quad -(23)$$

and is graphed and discussed. This is the first classical description of the Casimir type force, which is clearly understood as the force due to m space.

The anomalous g factor of the electron in m theory has been developed in UFT429. In quantum electrodynamics:

$$g = 2 + \frac{\alpha}{\pi} + O(\alpha^2) + \ldots \quad -(24)$$

Using the first method of UFT429, the g factor is:

$$g = \frac{2}{m(r)^{1/2}} \quad -(25)$$

so:

$$\frac{2}{m(r)^{1/2}} = 2 + \frac{\alpha}{\pi}, \quad -(26)$$

$$m(r) = 0.99942. \quad -(27)$$

The m ( $r$ ) function also be can be calculated from Eqs. ( 32 ) to ( 35 ). At a given value of r, m ( $r$ ) from Eqs. ( 32 ) to ( 35 ) will be the same as m $(r)$ from Eq. ( 26 ). This point r is related to the electron radius. It can be argued that the electron radius is a maximum from Eqs. ( 34 ) and ( 35 ). In the second method of UFT429:

$$g = \frac{4}{\frac{\hbar\omega}{mc^2} + m(r)^{1/2}} = 2 + \frac{\alpha}{\pi} + \ldots \quad -(28)$$

and $g$ can be calculated in terms of the angular frequency $\omega$ of the electron. For the rest electron:

$$\hbar\omega_0 = mc^2 \quad -(29)$$

so:

$$\frac{4}{1+m(r)^{1/2}} \doteq 2 + \frac{\alpha}{\pi} \quad -(30)$$

and

$$m(r) = 0.99884. \quad -(31)$$

One of the first radiative corrections to be inferred was vacuum polarization, which can be thought of as the screening of a point charge by the vacuum. This was inferred in 1934 by Dirac and Heisenberg independently. As described in Note 430(5), vacuum polarization changes the Coulomb potential to:

$$\phi(r) = -\frac{e}{4\pi\epsilon_0 r}\left(1 - \frac{2\alpha}{3\pi}\log_e\left(\frac{r}{\lambda_c}\right) + \ldots\right) \quad -(32)$$

for

$$\frac{r}{\lambda_c} \ll 1 \quad -(33)$$

and

$$\phi(r) = -\frac{e}{4\pi\epsilon_0 r}\left(1 + \frac{\alpha}{4\sqrt{\pi}}\left(\frac{r}{\lambda_c}\right)^{-3/2} e^{-2r/\lambda_c} + \ldots\right) \quad -(34)$$

for

$$\frac{r}{\lambda_c} \gg 1. \quad -(35)$$

Here :

$$\lambda_c = \frac{\hbar}{mc} \quad -(36)$$

and $\alpha$ is the fine structure constant defined in Eq. ( 3 ). In m theory:

$$\phi(r) = -m(r)^{1/2} \frac{e}{4\pi \epsilon_0 r} \quad -(37)$$

so m theory explains vacuum polarization immediately by choosing:

$$m(r)^{1/2} = 1 - \frac{2\alpha}{3\pi} \log_e \left( \frac{r}{\lambda_c} \right) + \ldots \quad -(38)$$

for

$$\frac{r}{\lambda_c} \ll 1 \quad -(39)$$

and

$$m(r)^{1/2} = 1 + \frac{\alpha}{4\sqrt{\pi}} \left( \frac{r}{\lambda_c} \right)^{-3/2} e^{-2r/\lambda_c} + \ldots \quad -(39)$$

for

$$\frac{r}{\lambda_c} \gg 1 \quad -(40)$$

It is seen that the Coulomb law is changed by vacuum polarization and m theory.

In classical electrodynamics, vacuum polarization changes the Coulomb law to:

$$\underline{\nabla} \cdot \underline{E} = \rho(\text{vac}) / \epsilon_0 \quad -(41)$$

where $\rho(\text{vac})$ is the vacuum charge density, and the Ampère Maxwell law to

$$\underline{\nabla} \times \underline{B} = \mu_0 \underline{J}(\text{vac}) + \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} \quad -(42)$$

where $\underline{J}(\text{vac})$ is the vacuum current density. Here $\underline{E}$ is the material electric field strength and $\underline{B}$ the material magnetic flux density. The vacuum permeability is $\mu_0$. Eq. ( 42 ) can be expressed as:

$$\nabla \times \underline{H} = \underline{J}(\text{vac}) + \frac{\partial \underline{D}}{\partial t} \quad -(43)$$

where:

$$\underline{D} = \epsilon_0 \underline{E} + \underline{P}(\text{vac}) \quad -(44)$$

and:

$$\underline{B} = \mu_0 \left( \underline{H} + \underline{M}(\text{vac}) \right). \quad -(45)$$

Here $\underline{P}(\text{vac})$ is the classical vacuum polarization and $\underline{M}(\text{vac})$ the classical vacuum magnetization. If there is no vacuum polarization and magnetization then:

$$\underline{D} = \epsilon_0 \underline{E}, \quad \underline{B} = \mu_0 \underline{H}, \quad -(46)$$

and Eq. (43) becomes Eq. (42), Q. E. D.

The ECE2 field equations predict the existence of the vacuum charge density and the vacuum current density as:

$$\rho(\text{vac}) = \epsilon_0 \underline{\kappa} \cdot \underline{E}(\text{vac}) \quad -(47)$$

and

$$\underline{J}(\text{vac}) = \frac{1}{\mu_0} \underline{\kappa} \times \underline{B}(\text{vac}) \quad -(48)$$

where $\underline{E}(\text{vac})$ and $\underline{B}(\text{vac})$ are classical vacuum fields. This concept is similar to that used on the quantum level in the Bethe theory of the Lamb shift. Here:

$$\kappa^\mu = \frac{2 q^\mu}{r^{(0)}} - \kappa^\mu \quad -(49)$$

where the tetrad four vector is:

$$q^\mu = (q^0, \underline{q}) \quad -(50)$$

and the spin connection four vector is:

$$\omega^{\mu} = (\omega^{0}, \underline{\omega}). \quad -(51)$$

Here $r^{(0)}$ is a characteristic length. The vacuum fields generate an energy density that can be compared with the energy density of m theory.

# General m theory of the radiative corrections

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## 3 Computation and discussion

### 3.1 Comparison with Q.E.D.

The vacuum polarizations functions of QED were given in Eqs. (32-36) of section 2. These can be compared with the m function according to Eqs. (37-40). We computed the vacuum polarization factors for the limits $r/\lambda_c \ll 1$ and $r/\lambda_c \gg 1$ and the m function used in this work:

$$\mathrm{m}(r) = 2 - \exp\left(\log(2)\exp(-\frac{r}{R})\right). \tag{52}$$

Using atomic units, we have

$$\lambda_c = 0.007297\,\mathrm{a}_0 \tag{53}$$

and the parameter $R$ was chosen as in UFT 429:

$$R = 0.0009\,\mathrm{a}_0. \tag{54}$$

The two QED functions were graphed, together with the square root of the above m function, in Fig. 1, and with an enhanced scale in Fig. 2. All three functions meet in the point $r = \lambda_c$ which is consistent. Similarly, for $r/\lambda_c \gg 1$ the limit 1 is reached in all cases. However, the QED function for $r/\lambda_c \ll 1$ goes to a limit $> 1$. This would mean $\mathrm{m}(r) > 1$ in our case. According to our results, an average value of $\mathrm{m}(r) > 1$ (being theoretically possible) gives a deepening of the level $2S_{1/2}$ instead of a lifting, which is the observed behaviour. Therefore the QED polarization function has to be doubted in this limit. Either not enough terms have been used in the series expansion (32), or the principal weakness of QED is revealed here.

We also evaluated the average energy of the Lamb shift obtained from QED:

$$\langle V\rangle = \alpha^5 mc^2 \frac{1}{6\pi}\log_e\left(\frac{1}{\pi\alpha}\right). \tag{55}$$

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By this formula, a Lamb shift comes out which is only half the experimental value of $4.372 \cdot 10^{-6}$eV. So far we could not resolve this discrepancy. It seems that the above formula (taken from Wikipedia) is erroneous, revealing further inconsistencies in QED literature.

### 3.2 Computation of Casimir force

It was shown in section 2, Eq. (20), that the Casimir force is

$$F = -\frac{d\mathrm{m}(r)}{dr}\left(\frac{\mathrm{m}(r)^{\frac{1}{2}}}{2\mathrm{m}(r) - \frac{d\mathrm{m}(r)}{dr}}\right) E_{\mathrm{kin}}. \tag{56}$$

Only the kinetic energy is involved in this expression. By defining

$$f(r) = -\frac{d\mathrm{m}(r)}{dr}\left(\frac{\mathrm{m}(r)^{\frac{1}{2}}}{2\mathrm{m}(r) - \frac{d\mathrm{m}(r)}{dr}}\right) \tag{57}$$

the expectation value of the Casimir force for atomic Hydrogen can be written:

$$\langle F \rangle = \langle f(r) E_{\mathrm{kin}} \rangle . \tag{58}$$

The corresponding integral can be evaluated in analogy to the method presented in UFT 328,3 where the factor $1/\mathrm{m}(r)^{\frac{1}{2}}$ has to be replaced by $f(r)/\mathrm{m}(r)^{\frac{1}{2}}$. Therefore we can write (omitting the potential energy):

$$\begin{aligned} \langle F \rangle = &-\frac{\hbar^2}{2m}\int \left(Y^* \nabla^2_{\theta,\phi} Y d\omega\right) \, R^* \frac{f(r)}{\mathrm{m}(r)^{\frac{1}{2}}} R \, r^2 dr \\ &-\frac{\hbar^2}{2m}\int R^* \frac{\partial}{\partial r}\left(\frac{f(r)}{\mathrm{m}(r)^{\frac{1}{2}}}\right)\frac{\partial R}{\partial r} \, r^2 dr. \end{aligned} \tag{59}$$

with the wave function definitions given in UFT 428. We evaluated the integrals numerically, with the m function (52) above and the parameter $R$ given by Eq. (54). The results are presented in Fig. 3 for the states $2S_{1/2}$ and $2P_{1/2}$. The physical values can be read at $R = 0.0009$. As expected, the force of the $S$ state is larger than that of the $P$ state because the Lamb shift is larger for $S$. The force values are in atomic units, whose force unit amounts to $8 \cdot 10^{-8}$N, giving the range of $10^{-14}$N for the averaged hydrogenic Casimir force.

### 3.3 Implications to nuclear physics

There is a resonance condition of the Casimir force, see Eq. (21). The force becomes maximal when the denominator goes to zero:

$$2\mathrm{m}(r) - r\frac{d\mathrm{m}(r)}{dr} \to 0. \tag{60}$$

This was already investigated in UFT 417,3. The resonance condition represents a differential equation for $\mathrm{m}(r)$ with the solution

$$\mathrm{m}(r) = Cr^2 \tag{61}$$

containing a constant $C$. In UFT 417,3 an m function was constructed which has this quadratic behaviour in the lower $r$ range (see Fig. 5 of UFT 417). Correspondingly, the force is infinite within this range (Fig. 6 in UFT 417). From the fact that there are no infinities in nature we can assume that $\mathrm{m}(r)$ has a horizontal tangent for $r \to 0$, thus justifying the quadratic growth in this range. Applying this finding to atomic nuclei, this means that there is a huge force of Casimir type inside the nucleus. The force rapidly decreases outside, where $\mathrm{m}(r)$ changes into a different form, for example the exponential form used in this work. The inner force represents a short-ranged nuclear force, which could possibly replace the strong and weak interaction of the standard model. This could also be a way of overcoming the phenomenological particle zoo, putting particle physics on an axiomatic theoretical basis.

From numerical models of atomic nuclei it is known that a shell model describes the structure of nuclei with lower cardinal number quite well. The nuclear potential is an averaged potential made up by protons and neutrons. This is similar as in all-electron calculations of the atomic and molecular electronic hull. The fact that the shell model does not work well for heavy nuclei could be related to missing inclusion of an m function.

Another point hitherto not discussed is that the m function changes the time coordinate. Therefore, in regions with $\mathrm{m}(r)$ deviating significantly from unity, the difference between proper time and observer time may be remarkable. The inner clock of atoms will deviate from that of an external observer. Such an argument is known from explaining the lifetime of fast mesons moving with nearly light velocity. It may be that atoms have an "inner life" lapsing quite slower than we do observe. This will will impact models of radioactive decay significantly.

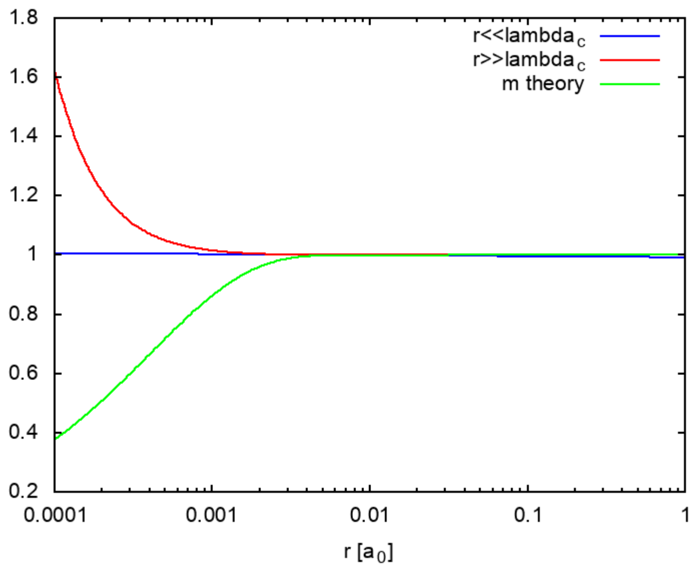


Figure 1: Comparison of vacuum polarization from QED and m theory.

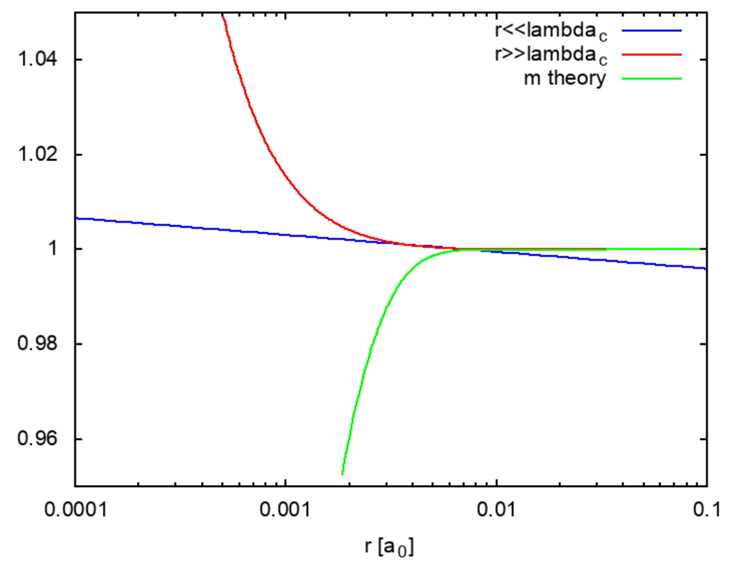


Figure 2: Comparison of vacuum polarization from QED and m theory, smaller scale.

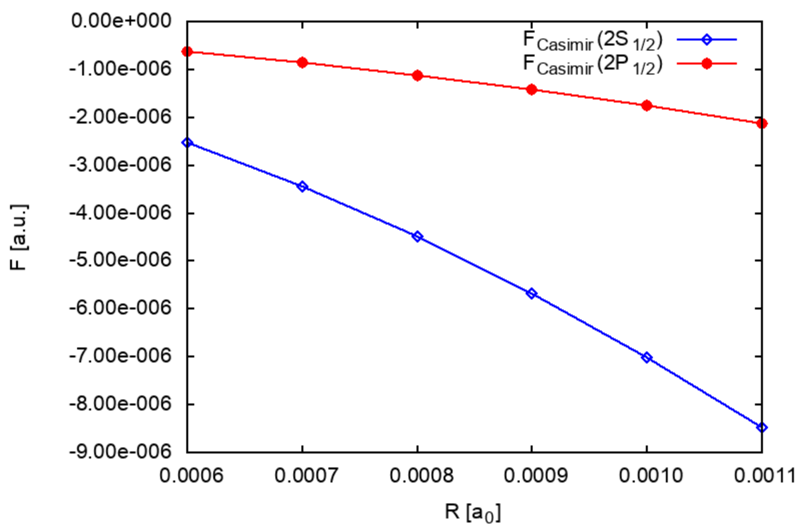


Figure 3: Casimir force of Hydrogen from m theory.

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