RULES FOR QUANTIZATION IN m SPACE

by

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ABSTRACT

The fundamental procedure for quantization in m space is defined, and consists of firstly transforming the wavefunction and then applying the usual quantization procedures, This method can be applied to any wavefunction, and when applied to the hydrogenic wavefunction produces the Lamb shift.

Keywords, ECE theory, ECE2, m theory fundamental quantization rules.

UFT435

1. INTRODUCTION

In the immediately preceding paper UFT434 {1 - 41} an approach to quantization of m theory was suggested by transforming the operators of the Schroedinger quantization. While this leads to interesting results, it is possible to transform the most fundamental concept of quantum mechanics, the wavefunction, and operate on the transformed wavefunction with the usual Schroedinger rules. This procedure is defined in Section 2 of this paper, and can be used for any wavefunction. In Section 2 it is illustrated with the free particle wavefunction, and in Section 3 it is shown that the procedure leads to a description of the Lamb shift when hydrogenic wavefunctions are used. The Lamb shift is due to the nature of m space itself. The standard model understands the Lamb shift as being due to the vacuum's oscillating electric and magnetic fields.

This paper is a short synopsis of extensive calculations given in the Notes accompanying UFT435 on www.aias.us. Note 435(1) discusses the properties of the time dependent Schroedinger equation in m space; Note 435(2) defines frame transformation of the hamiltonian; Note 435(3) discusses splittings and shifts due to these transformations; Note 435(4) discusses the free particle time dependent Schroedinger equation; Note 435(5) defines the fundamental transformations; and Note 435(6) suggests general rules for quantization in m space.

Section 2 is based on Note 435(6) and Section 3 produces the Lamb shift from the method established in Section 2.

2. RULES FOR QUANTIZATION

The rules are as follows.

1) Transform the wavefunction using:

$$r \rightarrow \frac{r}{m(r)^{1/2}}, \quad t \rightarrow m(r)^{1/2} t. \quad -(1)$$

2) Quantize the energy and momentum using:

$$E\psi = i\hbar \frac{\partial \psi}{\partial t}, \quad \underline{p}\psi = -i\hbar \underline{\nabla} \psi. \quad -(2)$$

Consider their application to the free particle wavefunction:

$$\psi(t, r) = \exp(-i(\omega t - \kappa r)) \quad -(3)$$

where ω is the angular frequency at instant t and κ is the magnitude of the wavevector at point r. The wavefunction is considered to be the most fundamental concept of quantum mechanics, and in m theory quantum mechanics is unified with general relativity. Using the first rule the free particle wavefunction in m space (or equivalently in contact with the vacuum) is:

$$\psi(t, r) = \exp\left(-i\left(m^{1/2}(r)\,\omega t - \frac{\kappa r}{m(r)^{1/2}}\right)\right) \quad -(4)$$

Here m (r) is defined by the infinitesimal line element as in UFT416.

The time dependent Schroedinger equation is:

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi. \quad -(5)$$

The hamiltonian is transformed to:

$$H = \frac{p^2}{2m\,m(r)} \quad -(6)$$

and considered for simplicity as the classical limit of the kinetic energy of the free particle in m space. Therefore $\underline{p}$ is the momentum of the particle and m is its mass. The transformation of t and p in rule one is based on the infinitesimal line element of m space, a concept of geometry. It follows from Eqs. (2) and (3) that:

$$E = i\hbar\int \psi^* \frac{\partial \psi}{\partial t}\, d\tau = -\frac{\hbar^2}{2m}\int \psi^* \nabla^2 \psi\, d\tau \quad -(7)$$

in which the wavefunction is defined by Eq. (4). It follows from Eq. (5) that:

$$\frac{\partial \psi}{\partial t}(r,t) = -i m^{1/2}(r)\,\omega\,\psi(r,t) \quad -(8)$$

so:

$$E = \hbar\omega\int \psi^* m^{1/2}(r)\,\psi\, d\tau \quad -(9)$$

The Planck quantization is modified by the expectation value:

$$\langle m^{1/2}(r)\rangle = \int \psi^* m^{1/2}(r)\,\psi\, d\tau \quad -(10)$$

of $m^{1/2}(r)$, calculated with the wavefunction of Eq. (5). In the limit:

$$m(r) \rightarrow 1 \quad -(11)$$

the Planck quantization is obtained:

$$E = \hbar\omega \quad -(12)$$

because:

$$\int \psi^* \psi\, d\tau = 1. \quad -(13)$$

Therefore for the free particle

$$E = \hbar\omega \int \psi^{*} m^{1/2}(r)\, \psi \, d\tau = -\frac{\hbar^{2}}{2m} \int \psi^{*} \nabla^{2} \psi \, d\tau. \quad \text{---}(14)$$

For a radial wavefunction:

$$E = \hbar\omega \int \psi^{*} m^{1/2}(r)\, \psi \, d\tau = -\frac{\hbar^{2}}{2m} \int \psi^{*} \frac{\partial^{2}}{\partial r^{2}} \left(\frac{i\kappa r}{m(r)^{1/2}} \right) d\tau \quad \text{---}(15)$$

and in the limit:

$$m(r) \rightarrow 1 : \quad \text{---}(16)$$

$$E = \hbar\omega = \frac{\hbar^{2}\kappa^{2}}{2m}. \quad -(17)$$

These are the usual free particle energy levels from the Schroedinger equation. They are split and shifted by modifying the m space to give Eq. (15). Modifying the m space is equivalent to introducing the effect of the vacuum.

This method is applied with the hydrogenic wavefunctions in Section 3 to show that rule one gives the Lamb shift.

Rules for quantization in m space

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3 Vacuum effect of m space for Hydrogenic wave functions

According to Eq. (15) the free-particle expectation value of energy is modified in m space to

$$E = \hbar\omega \int \psi^* \, \mathrm{m}(r)^{1/2} \, \psi \, d\tau. \tag{18}$$

The integral is the expectation value $\langle \mathrm{m}(r)^{1/2} \rangle$. We use the wave functions of Hydrogen to compute this expectation value. The energy is then impacted by a correction factor

$$\hbar\omega \rightarrow \hbar\omega \left\langle \mathrm{m}(r)^{1/2} \right\rangle. \tag{19}$$

For evaluating the integral we use three model m functions similar as in UFT 434:

$$\mathrm{m}_1(r) = 2 - \exp\left(\log(2)\, \exp\left(\frac{-r}{R}\right)\right) \tag{20}$$

$$\mathrm{m}_2(r) = 1 - \exp\left(\frac{-r}{R}\right) \tag{21}$$

$$\mathrm{m}_3(r) = \frac{r^2}{r^2 + 2\frac{R}{k} r + \left(\frac{R}{k}\right)^2} \tag{22}$$

The first is the m function used earlier, the second is a simplified version thereof. The third $\mathrm{m}(r)$ is a rational function with an additional scaling constant k. In Fig. 1 these m functions are graphed with parameter $R = 0.009\, a_0$ and $k = 5$. Using a too mall k stretches $\mathrm{m}_3(r)$ to the right so that it approaches unity too slowly.

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The radius R was used as a parameter to evaluate the integral in (18). We used the analytical wave functions of Hydrogen and put R in the range being found relevant when computing the Lamb shift in UFT 429. The shifts for the second principal quantum number are graphed in Fig. 2, together with the experimental Lamb shift value of $2S_{1/2}$. Depending on the form of the m function (m_1 or m_2, denoted by A and B), the shift is reached for $R \approx 0.015$ Bohr radii. It is seen that

1. only the s orbitals are impacted, not the p orbitals, and
2. since $\langle \mathrm{m}(r)^{1/2} \rangle < 1$ there is a reduction in the modulus of the binding energy.

Both effects are observed experimentally. This greatly corroborates the correctness of m theory. For comparison, the results for the rational function m_3 is shown in Fig. 3. Here the scaling factor had to be increased to $k = 1000$, otherwise the shifts would overestimate the Lamb shift by orders of magnitude. As a second problem, the shifts of s and p orbitals are nearly identical, as opposed to the experimental finding. The problem of m_3 is that rational (i.e. polynome based) functions have long-reaching asymptotes, in this case $\mathrm{m}_3 \rightarrow 1$. Therefore not only s like orbitals, which have a non-vanishing probability density at $r = 0$, are impacted but also orbitals with centre of probablility density at $r > 0$.

In Fig. 4 the shifts of s states of the first three principal quantum number are graphed. It is seen that the shifts decrease significantly with higher principal quantum number. The effect is largest for $1S_{1/2}$ but there is no experimental value in relation to which a splitting could be observed. It would only be possible to compare this with the non-relativistic $1s$ energy of the Schrödinger equation as a theoretical value.

We can compare the optimized R parameter of 1.5e-2 a_0 with the proton radius which is 1.6e-5 a_0. The latter is one thousandth of R. Obviously the m function reaches far beyond the nucleus before it takes its far field limit of unity. The fact that only s orbitals are impacted is less plausible if we assume fluctuating electromagnetic fields of the vacuum to be responsible for the Lamb shift. Then all types of orbitals should be impacted in a similar way. The fact that this effect is restricted to the region of the atomic nucleus supports the view of m theory. Space is distorted only where the local mass density is very high.

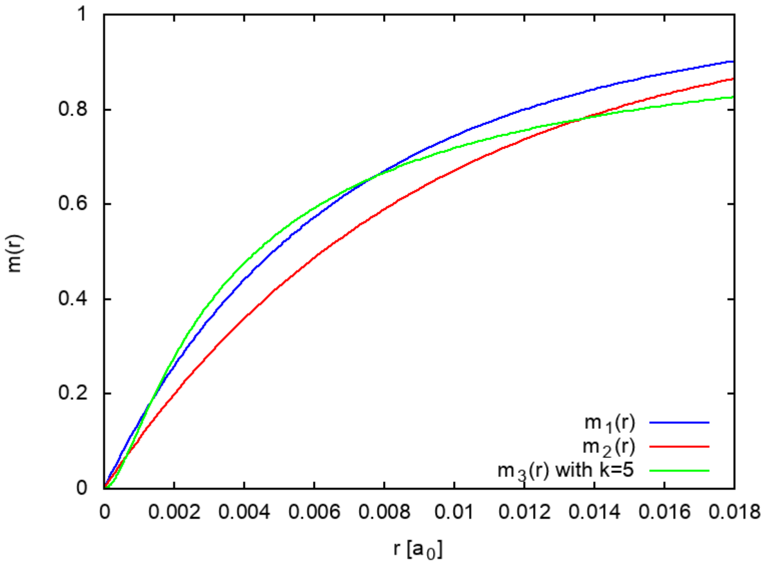

Figure 1: m functions of Eqs. (20-22) with R=9e-3 a_0 and $k = 5$.

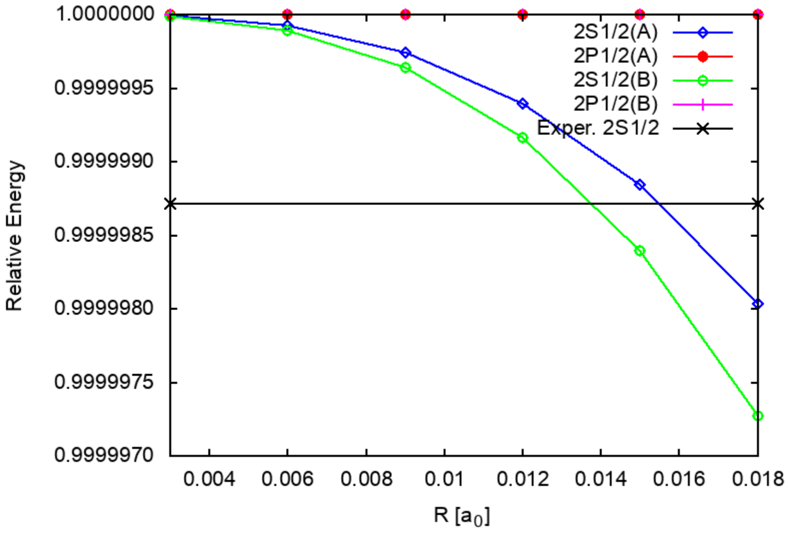

Figure 2: Lamb shift factors of $\mathrm{m}_1(r)$ (A) and $\mathrm{m}_2(r)$ (B).

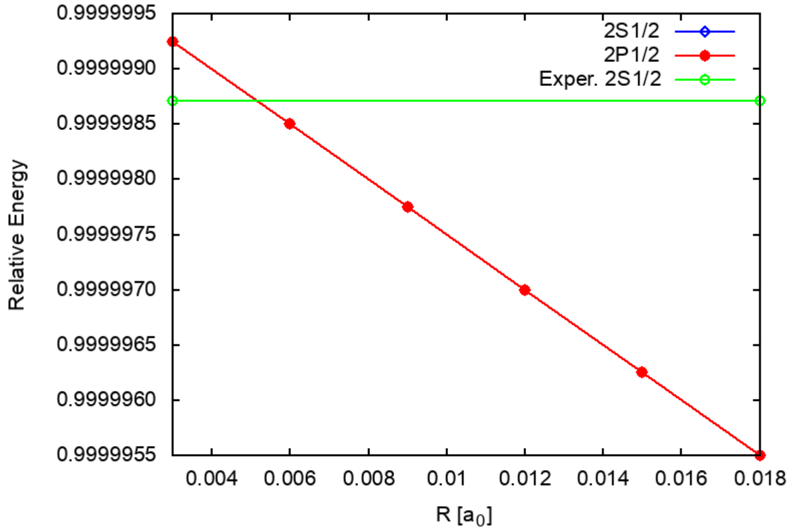

Figure 3: Lamb shift factors of $m_3(r)$.

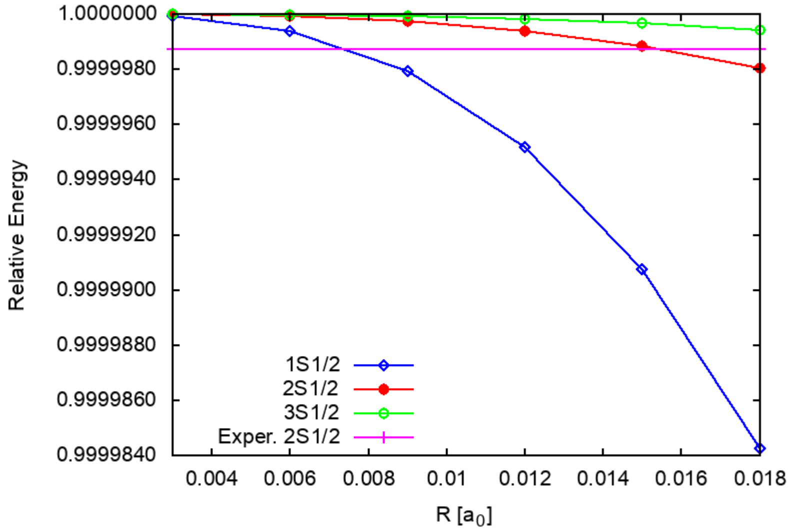

Figure 4: Energy shift factors of states $1S_{1/2}$, $2S_{1/2}$ and $3S_{1/2}$.

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