ECE2 THEORY OF THE LAMB SHIFT FROM THE AHARONOV BOHM VACUUM

by

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ABSTRACT

The ECE2 theory is developed of the anomalous g factor of the electron and the Lamb shift using the inference that the Aharonov Bohm type vacuum consists of wave particles which can transfer energy / momentum to elementary particles. It is shown that momentum transfer results in a well defined energy shift. The conventional Lamb shift theory, based on a fluctuating Coulomb potential, is developed in terms of energy transferred by the vacuum wave particle. The Aharonov Bohm type vacuum is defined in terms of ECE2 theory.

Keywords: ECE2, anomalous g factor of electron, Lamb shift, Aharonov Bohm vacuum

UFT340

1. INTRODUCTION

In recent papers of this series {1 - 12} it has been shown that the ECE2 vacuum is an Aharonov Bohm type vacuum made up of wave particles of well defined energy momentum. The radiative corrections are the result of transfer of this energy momentum to elementary particles. This process results in well observed effects such as the anomalous g factors of elementary particles such as the electron, muon, proton and neutron, the Lamb shift, the Casimir effects and so on. In this paper, the ECE2 equations of this energy momentum transfer are developed to give a coherent theory of the anomalous g factor of the electron and Lamb shift, thus identifying novel and observable processes of momentum transfer. The conventional theory of the Lamb shift depends on the assumption that the electron in an H atom for example fluctuates due to the presence of the vacuum. This is the well known phenomenon of jitterbugging. It is shown that the latter is due to the vacuum energy of ECE2 theory, and the observed Lamb shift is used to calculate a novel mean vacuum angular frequency. The Aharonov Bohm vacuum is defined in terms of ECE2 theory, thus providing a novel theory of the B(3) field.

This paper is a concise summary of extensive calculations given in the Notes accompanying UFT340 on www.aias.us. Note 340(1) develops the ECE2 theory of the anomalous g factor and Lamb shift and defines g in terms of the relativistic hamiltonian. Note 340(2) defines a process of transfer of linear momentum from an ECE2 wave / particle. Resulting in an observable energy shift in the spectra of atoms and molecules. Notes 340(3) and 340(4) develop the conventional Lamb shift theory by use of a fluctuating Coulomb potential, and uses the observed value of the Lamb shift in atomic hydrogen to define a novel mean vacuum angular frequency. Finally Notes 340(5) and 340(6) define the Aharonov Bohm vacuum in ECE2 theory and define the B(3) field.

2. TRANSFER OF VACUUM ENERGY MOMENTUM

By considerations of the Einstein energy equation in ECE2 theory, and by use of the minimal prescription as defined in Notes 340(1) and 340(2), it can be shown that the anomalous g factor of the electron is defined by:

$$g = 1 + \frac{H}{mc^2} \quad -(1)$$

where H is the relativistic hamiltonian:

$$H = \gamma mc^2 + U. \quad -(2)$$

Here m is the particle mass, c the vacuum speed of light, U the potential energy and γ is the Lorentz factor. For a static electron, the de Broglie equation asserts that:

$$\hbar\omega_0 = mc^2 \quad -(3)$$

where ω_0 is the rest angular frequency of the electron and $\hbar$ is the reduced Planck constant. Therefore for a static electron Eq. (2) reduces to:

$$g = 2 + \frac{\hbar\omega(\mathrm{vac})}{mc^2} \quad -(4)$$

as shown in immediately preceding papers. In general the anomalous g factor of the electron is:

$$g = 1 + \frac{\hbar(\omega + \omega(\mathrm{vac}))}{mc^2} \quad -(5)$$

where ω is the angular frequency of the electron wave, and where $\omega(\mathrm{vac})$ is the angular frequency of the ECE2 vacuum wave particle. In Note 340(2) it is shown in complete detail that the process of momentum transfer from the vacuum wave particle results in the observable frequency shift:

$$\Delta E = \frac{-e^2}{4\pi\epsilon_0 g m^2 c^2}\left\langle \frac{\underline{S}\cdot\underline{L}(vac)}{r^3}\right\rangle. \quad -(6)$$

Here e is the modulus of the charge on the electron, ϵ_0 is the S. I. permittivity in vacuo, $\underline{S}$ the spin angular momentum of the electron, and $\underline{L}(vac)$ is the electronic orbital angular momentum induced in an atom or molecule by the ECE2 vacuum. Various methods of calculating this shift are described in Note 340(3).

Therefore momentum as well as energy can be transferred from the ECE2 vacuum. In Note 340(4) the ECE2 vacuum potential energy is defined as:

$$U(vac) = e\phi_W(vac) = \hbar c \Omega^0(vac) = \hbar\omega(vac). \quad -(7)$$

where $\phi_W(vac)$ is the ECE2 potential, Ω^0 the scalar spin connection of the ECE2 vacuum, and $\omega(vac)$ the vacuum angular frequency of a single vacuum wave particle. The Coulomb potential U_c between an electron and proton in the hydrogen atom for example is augmented by the ECE2 vacuum as follows:

$$U_c \rightarrow U_c + U(vac) = -\frac{e^2}{4\pi\epsilon_0 r} + \hbar\omega(vac) \quad -(8)$$

Following the well known 1947 idea and calculation by Bethe {1 - 10}, it is assumed that U_c fluctuates, so as described in Note 340(3):

$$U_c = U(\underline{r} - \delta\underline{r}) - U(\underline{r}) \quad -(9)$$

where $\delta\underline{r}$ is the jitterbugging in the position of the electron due to the ECE2 vacuum. This idea implies that the vacuum potential is:

$$U(vac) = \hbar\omega(vac) = -\frac{e^2}{4\pi\epsilon_0}\left(\frac{1}{r-\delta r} - \frac{1}{r}\right) \quad -(10)$$

This equation can be expressed as:

$$U(vac) = \hbar\omega(vac) = \frac{e^2 \, \delta r}{4\pi\epsilon_0 (r - \delta r) r} \qquad (11)$$

and the change in potential energy due to the ECE2 vacuum is, self consistently:

$$\Delta U = U(vac) = U(\underline{r} - \delta \underline{r}) - U(\underline{r}). \qquad (12)$$

If it is assumed that:

$$\delta \underline{r} \ll \underline{r} \qquad (13)$$

Eq. (11) can be written as:

$$U(vac) = \hbar\omega(vac) = \frac{e^2}{4\pi\epsilon_0} \left(\frac{\delta r}{r^2} + \frac{(\delta r)^2}{r^3} \right). \qquad (14)$$

Averaging over an ensemble of vacuum wave particles:

$$\langle U(vac) \rangle = \hbar \langle \omega(vac) \rangle = \frac{e^2}{4\pi\epsilon_0} \left(\frac{\langle \delta r \rangle}{r^2} + \frac{\langle (\delta r)^2 \rangle}{r^3} \right). \qquad (15)$$

In Bethe's original 1947 calculation it is assumed that:

$$\langle \delta \underline{r} \rangle = \underline{0}. \qquad (16)$$

Accepting this assumption it follows that:

$$\langle \omega(vac) \rangle = \frac{e^2}{4\pi\epsilon_0 \hbar r^3} \langle (\delta r)^2 \rangle = \frac{c\alpha}{r^3} \langle (\delta r)^2 \rangle \qquad (17)$$

where α is the fine structure constant.

The mean square fluctuations give rise to a mean vacuum angular frequency.

By using a Maclaurin series expansion of the equation:

$$\Delta U = U(\underline{r}+\delta\underline{r}) - U(\underline{r}) \quad -(18)$$

it can be shown that:

$$\langle \Delta U \rangle = \frac{1}{6}\langle (\delta r)^2 \rangle \nabla^2 U_c. \quad -(19)$$

For the $^2S_{1/2}$ orbital of the hydrogen atom {1 - 12}:

$$\langle \nabla^2 U_0 \rangle = \left\langle \nabla^2 \left(\frac{-e^2}{4\pi\epsilon_0 r} \right) \right\rangle = \frac{e^2}{\epsilon_0} |\phi(0)|^2 \quad -(20)$$

where $\phi(0)$ is the value of the $^2S_{1/2}$ wavefunction of hydrogen at the origin:

$$|\phi_{2S_{1/2}}(0)|^2 = \frac{1}{8\pi a_0^3} \quad -(21)$$

where a_0 is the Bohr radius. From Eqs. (19) and (17) the Lamb shift in the $^2S_{1/2}$ energy level of the H atom is:

$$\langle \Delta U \rangle = \frac{e^2 r^3}{48 \epsilon_0 a_0^3 d c} \langle \omega(vac) \rangle. \quad -(22)$$

The measured Lamb shift is:

$$\Delta f = 1.058 \times 10^9 \, Hz \sim 0.04 \, cm^{-1} \quad -(23)$$

where:

$$\langle \Delta U \rangle = 2\pi \hbar \Delta f. \quad -(24)$$

Computing expectation values from the hydrogenic wavefunctions, it is found that:

$$\frac{\langle r \rangle}{a_0}(1s) = \frac{3}{2}; \quad \frac{\langle r \rangle}{a_0}(2s) = 6; \quad \frac{\langle r \rangle}{a_0}(3s) = \frac{27}{2}. \quad -(25)$$

The relevant value for $^2S_{1/2}$ is:

$$\frac{r}{a_0} = \frac{\langle r \rangle}{a_0} = 6. \quad -(26)$$

This gives the mean vacuum angular frequency of an ensemble of vacuum wave particles:

$$\langle \omega(\mathrm{vac}) \rangle = \frac{96\pi \epsilon_0 \alpha \hbar c \Delta f a_0^3}{e^2 r^3} = 3.96750 \times 10^8 \ \mathrm{rad\,s^{-1}} \quad -(27)$$

The de Broglie frequency of one vacuum particle calculated in immediately preceding papers is:

$$\omega(\mathrm{vac}) = 1.80058 \times 10^{18} \ \mathrm{rad\,s^{-1}}. \quad -(28)$$

So ensemble averaging results in the fact that the ensemble averaged frequency is much lower than the de Broglie frequency. The mean vacuum angular frequency indicates a very tiny anisotropy in the distribution of the vacuum wave particles, and this is responsible for the Lamb shift in $2S_{1/2}$. This tiny anisotropy in the vacuum is a universal property, and indicates a tiny anisotropy in the universe itself. For example it is claimed that there is an anisotropy in the microwave background radiation as is well known. There is no Lamb shift in $2P_{1/2}$ because the $2P_{1/2}$ wavefunction vanishes at the origin as is well known.

Finally the structure of the Aharonov Bohm vacuum is developed with ECE2 theory in Notes 340(6) and 340(7), in which a new relation between $\underline{A}$ and $\underline{W}$ vector potentials is used for the first time:

$$\underline{A}^a = -e^b \underline{W}^a{}_b \quad -(29)$$

where $\underline{e}^b$ is the unit four vector in the tangent spacetime of Cartan geometry. It is shown that this assumption results in the useful results:

$$\underline{W}^a = \underline{A}^a \quad -(30)$$

and

$$W^{(0)} \underline{R}^a = A^{(0)} \underline{T}^a \quad -(31)$$

where $\underline{R}^a$ is the spin curvature vector and $\underline{T}^a$ the spin torsion vector. The elementary quantized value of $W^{(0)}$ is:

$$W^{(0)} = \frac{\hbar}{e} \quad -(32)$$

in units of magnetic flux (weber). Here $A^{(0)}$ has the units of weber per metre. Eq. (31) shows that if torsion is zero, so is curvature. So the Einstein theory is fundamentally incorrect because it uses zero torsion and non-zero curvature. This was first pointed out in papers such as UFT88, UFT99 and UFT109, developed in to UFT313.

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