MEASUREMENT OF THE REST MASS OF THE PHOTON FROM ANY ABSORPTION.

by

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ABSTRACT

Various methods are suggested for the experimental measurement of the photon rest mass, predicted by the B(3) field and ECE unified field theory. It is concluded that the optiaml method is to use the Beer Lambert Law for monochromatic radiation in combination with the Planck distribution modified for photon rest mass. The existence of photon rest mass changes the Rayleigh Jeans density of states by replacing the d'Alembert equation with the Proca equation.

Keywords: ECE theory, B(3) field, photon rest mass, experimental method for measuring the photon rest mass from any absorption.

UFT 312

1. INTRODUCTION

In recent papers of this series, rigorous new test of the quantum theory have been devised using a straightforward and simple combination of the Planck distribution and the Beer Lambert law {1 - 12}. This method shows that incident probe frequencies are red shifted in any absorption process, a phenomenon first observed about a century ago in the cosmological red shift. The phenomenon has been demonstrated recently in the condensed matter by G. J. Evans and T. Morris in a series of reproducible and repeatable experiments and these Evans / Morris effects appear on the diary or blog of www.aias.us. They have catalyzed a series of ECE papers which resulted in several new and rigorous tests of the quantum theory itself.

In this paper a number of methods are suggested for the measurement of photon rest mass by developing recent UFT papers. Various methods are described in detail in the notes accompanying UFT312 on www.aias.us. Note 312(1) develops a method based on monochromatic radiation to calculate the moving mass of the photon, defined as the rest mass multiplied by the Lorentz factor. In this note expressions are given for the real and imaginary parts of the refractive index using general absorption theory. Note 312(2) develops a method for measuring photon rest mass with extremely low frequencies (ELF), exemplified by the mains frequency, and gives an expression for monochromatic flux density from the mains. In Note 312(3) the classical theory of dipole radiation is compared with the quantum mechanical Planck distribution using the principle of quantum classical equivalence, and an expression given for calculating the power in watts from the flux density in watts per square metre using spherical polar coordinates. In Note 312(4) the method is extended to half wave antenna theory, a relation given between power and current, and a method developed for measuring the photon rest mass. In Note 312(5) a calculation is given of the Rayleigh Jeans density of states in the presence of photon rest mass, and conditions suggested under which the effect of photon mass on the polychromatic Stefan Boltzmann law is maximized. The optimal method for the measurement of photon rest mass is developed in Notes 312(6) and 312(7), and this method is described in Section 2. In Section 3 a graphical and computational analysis of Section 2 is given.

2. PHOTON REST MASS FROM ANY MONOCHROMATIC ABSORPTION.

Consider the flux density Φ in watts per square metre of monochromatic radiation at an angular frequency ω. From the work of recent UFT papers this quantity can be calculated in the presence of photon rest mass m_0 by replacing the d'Alembert equation used in the Rayleigh Jeans density of states by the Proca equation. The result is:

$$c\frac{E}{V} = \Phi = \frac{\hbar\left(\omega^2 - \omega_0^2\right)^2}{3c^2\pi^2\left(e^y - 1\right)} \quad -(1)$$

where c is the vacuum speed of light, and E / V is the energy density of the radiation in joules per cubic metre. In Eq. (1), ω_0 is the de Broglie rest angular frequency of the photon:

$$\omega_0 = m_0 c^2 / \hbar \quad -(2)$$

where m_0 is the mass of the photon and where $\hbar$ is the reduced Planck constant. In Eq. (1):

$$y = \frac{\hbar\omega}{kT} \quad -(3)$$

where k is the Boltzmann constant and where T is the temperature.

Now consider the well known Beer Lambert law:

$$\frac{\Phi}{\Phi_i} = \exp(-\alpha l) \quad -(4)$$

where Φ_i is the flux incident on an absorption sample of power absorption coefficient α and sample path length l. The flux Φ is defined by a product of the power absorption coefficient and the sample path length l. For example in the cosmological red shift l can be millions of light years. In the laboratory l can be of the order of millimetres to metres. The power absorption coefficient can be calculated from the transition electric dipole moment or measured experimentally as a function of frequency or wavenumber.

Now consider the absorption of monochromatic radiation. From Eq. (1), the incident flux density Φ_i is defined in terms of the incident monochromatic frequency as follows:

$$\Phi_i = \frac{\hbar\left(\omega_i^2 - \omega_0^2\right)^2}{3c^2\pi^2\left(e^{y_i} - 1\right)} \quad -(5)$$

where:

$$y_i = \frac{\hbar\omega_i}{kT}. \quad -(6)$$

The absorbed flux density at path length l is defined by:

$$\Phi = \frac{\hbar\left(\omega^2 - \omega_0^2\right)^2}{3c^2\pi^2\left(e^{y} - 1\right)} \quad -(7)$$

Note carefully that there has been a frequency shift from the incident ω_i to the absorbed ω. This is the cosmological red shift or the Evans Morris shift in condensed matter. The frequency shift is determined by the power absorption coefficient and the path length l. The longer the path length the greater the shift. The more the absorption as measured by the power absorption coefficient the greater the shift.

From Eqs. (4), (5) and (7):

$$\frac{\omega^2 - \omega_0^2}{\omega_i^2 - \omega_0^2} = \left(\frac{e^{y} - 1}{e^{y_i} - 1} \right) \exp\left(-\frac{\alpha l}{2} \right) := A \quad -(8)$$

so the photon rest frequency is given by:

$$\omega_0^2 = \frac{\omega^2 - A\omega_i^2}{1 - A} \quad -(9)$$

and can be calculated given the incident and absorbed frequencies, the power absorption coefficient and the path length. All these quantities can be measured experimentally. Note carefully that the photon rest frequency is theoretically a constant. In massless photon theory:

$$\omega_0 = 0 \quad -(10)$$

and we recover the result of the Rayleigh Jeans Planck law combined with the Beer Lambert law as in previous UFT papers.

$$\left(\frac{\omega}{\omega_i} \right)^2 = A . \quad -(11)$$

Eq. (9) is a rigorous new test of the concept of photon rest mass and of the quantum theory.

3. GRAPHICAL AND NUMERICAL ANALYSIS OF EQ. (9).

Section by Dr. Horst Eckardt.

Measurements of the rest mass of the photon from any absorption

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3 Graphical and numerical analysis of Eq.(9)

The final result (9) for the rest frequency of the photon was

$$\omega_0^2 = \frac{\omega^2 - A\,\omega_i^2}{1-A} \tag{12}$$

with

$$A = \sqrt{\frac{\omega}{\omega_i}}\exp(-\frac{\alpha l}{2}) \tag{13}$$

in the low frequency/high temperature limit. The quantity A depends on both frequencies ω and ω_i, therefore the result is more difficult for experimental verification than it seems. Numerator and denominator of (12) have to have the same sign to give a positive result. It is plausible from the definition (13) that we always have

$$A < 1. \tag{14}$$

Then it must be

$$\omega^2 - A\,\omega_i^2 > 0 \tag{15}$$

or

$$\omega^2 > A\,\omega_i^2. \tag{16}$$

This condition is not valid in general because we have

$$\omega_i > \omega \tag{17}$$

which restricts the value of A significantly. The range of ω to be measured can be calculated by setting $\omega_0 \approx 0$. Then from (12) follows

$$\omega^2 - A\,\omega_i^2 = 0. \tag{18}$$

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From this equation ω can be determined. Due to the ω dependence of A, solving this equation is non-trivial, an equation of eighth order follows, giving the only real, non-vanishing solution

$$\omega_{\mathrm{crit}} = \omega_i \exp(-\frac{\alpha l}{3}). \tag{19}$$

The true value of ω then lies slightly above ω_{crit}. Setting parameters

$$\alpha = 1000/\mathrm{m}, \quad l = 0.001\mathrm{m}, \quad \omega_i = 10^{10}/\mathrm{s} \tag{20}$$

leads to

$$\omega_{\mathrm{crit}} = 7.17 \cdot 10^9/\mathrm{s} \tag{21}$$

which is near to ω_i. Function (12), i.e. ω_0^2, is graphed in Fig. 1 in dependence of ω. Physical values start where the function becomes positive. It can be seen that the slope there is very high. Therefore it is very difficult to get a precise ω value from experiment. This must be precise in ten digits, assuming that the photon mass frequency is about $1/\mathrm{s}$.

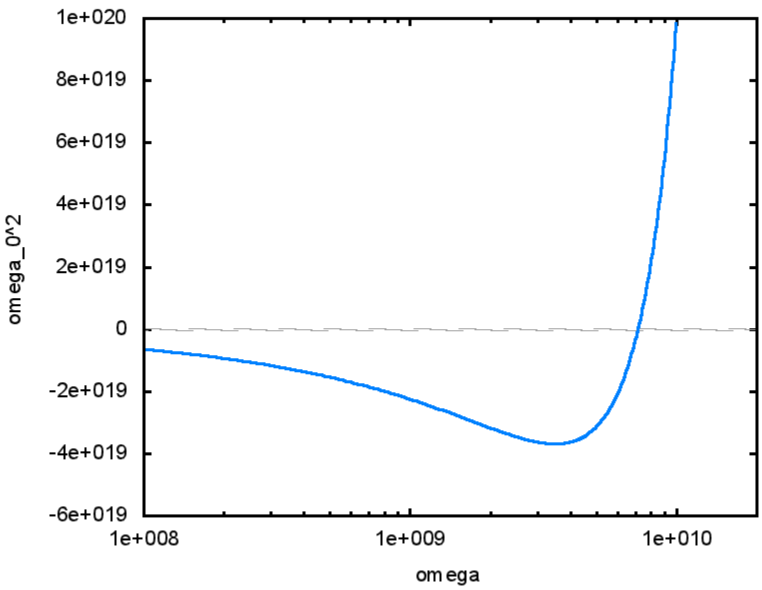

Figure 1: Frequency dependency of ω_0^2 from ω.

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