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NON ABELIAN QUANTUM ELECTRODYNAMICS: CORRECTIONS TO THE LAMB SHIFT AND G FACTOR.

by

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ABSTRACT

The theory of quantum electrodynamics is developed with an O(3) gauge group symmetry suggested by the empirical observation of the optical conjugate product of the quantized electromagnetic field.. The theory produces the photomagneton operator, a quantized magnetic field operator longitudinally directed in vacuo. This operator is defined through the commutator of creation and annihilation operators corresponding to the classical and observable conjugate product $\underline{A} \times \underline{A}^*$ of complex vector potentials. Corrections to the Lamb shift and electronic g factor take effect at order five in the fine structure constant.

1. INTRODUCTION

Quantum electrodynamics is usually considered to be the most precise theory in physics, but is nevertheless incomplete. Corrections are expected due to the observable existence of the quantized equivalent of the classical conjugate product $\underline{A} \times \underline{A}^*$ of complex vector potentials. In a complex spherical basis {1-5} this is conveniently denoted by $\underline{A}^{(1)} \times \underline{A}^{(2)}$, and is observable in magneto-optical effects. It also occurs in the third Stokes parameter {6} through which ordinary circular polarization is characterized. In the U(1) symmetry gauge field theory that is used for quantum electrodynamics, this observable $\underline{A}^{(1)} \times \underline{A}^{(2)}$ is assumed to be zero, and this is a fundamental self-inconsistency {1-5}. If we are to accept that quantum electrodynamics is based on gauge field theory a non-Abelian symmetry is required for the internal gauge group. It is natural to choose O(3) in the basis ((1), (2), (3)) because this basis originates in circular polarization, a fundamental property of radiation.

On the classical level the choice of O(3) for the internal gauge symmetry implies the existence of a magnetic component in radiation that is parallel to the propagation axis:

$$\underline{B}^{(3)*} = -ig\underline{A}^{(1)} \times \underline{A}^{(2)} \quad -(1)$$

where g is a proportionality constant which in the vacuum (free field) is e /h, the ratio of the charge on the electron to the Planck constant. The constant g is inversely proportional to the quantum of magnetic flux. In order to develop quantum electrodynamics as an O(3) symmetry gauge field theory, therefore, the quantized equivalent of the conjugate product $\underline{A} \times \underline{A}^*$ must be incorporated in the lagrangian and hamiltonian describing the interaction of an electron and a photon. This is developed in Section 2. In Section 3 the corrections to the Lamb shift and electronic g factor of the electron are calculated and exemplified in atomic H. It turns out that the corrections are minute but important, because measurements such as these will show whether or not quantum electrodynamics is really a gauge field theory that can self consistently take account of the existence of the classical observable $\underline{A}^{(1)} \times \underline{A}^{(2)}$. If the O(3) gauge calculations given here agree with precise data then it is likely that quantum electrodynamics is a valid gauge field theory. If not, quantum electrodynamics, despite its precision, will have been shown to be a self-inconsistent theory.

2. ELECTRON PHOTON INTERACTION IN O(3) ELECTRODYNAMICS.

(Dr. Crowell)

3. CORRECTIONS TO THE G FACTOR OF THE ELECTRON AND THE LAMB SHIFT OF ATOMIC H.

(Dr. Crowell)

4. DISCUSSION

(Dr. Crowell and others)

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