Implications of radiative corrections for the particle-zeropoint field system: establishing contact with quantum electrodynamics

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In a previous work [1], quantum mechanics was derived by studying the problem of an otherwise classical particle – say an atomic electron – immersed in the stochastic zero-point field. Detailed balance was assumed to have been achieved between the power lost by the particle through radiation reaction and the power gained by it from the zero-point field. Considering that the background field had played its most important role by leading the system to this situation, the radiationless approximation – which is taken by neglecting terms that represent mere radiative corrections – then led to the Schrödinger equation, except for an undetermined parameter β proportional to Planck's constant, which entered as a measure of the intensity of the fluctuations induced by the zero-point field.

In this work we proceed to the determination of the value of β, by using explicitly the detailed-balance condition; the parameter is thus shown to have the universal value $\beta = \hbar/2$. This completes the derivation of the Schrödinger equation in the radiationless approximation.

Some major consequences of the radiative terms previously neglected are then investigated. Firstly, the specific contributions of both the background field and the radiation reaction to the rate of atomic transitions are calculated. The results reproduce exactly the quantum formulas for the Einstein A and B coefficients, assigning an unequivocal meaning to these formulas. Other important radiative corrections, such as the shift of the atomic levels and the accompanying mass correction due to the residual effects of the zero-point field and radiation reaction, are shown to also be given by our equations. The theory allows thus to recover results that are usually considered to pertain to the specific province of quantum electrodynamics.

[1] L. de la Pena, A. M. Cetto and A. Valdés-Hernández, abstract submitted to this conference.