COMMENTS ON COLE AND ZOU’S CALCULATION OF THE HYDROGEN GROUND STATE IN CLASSICAL PHYSICS

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Cole and Zou’s computer-simulation calculation of the hydrogen ground state in classical electrodynamics with classical electromagnetic zero-point point radiation suggests that the problem of atomic collapse in atomic physics may have been solved. Analytic calculations of the early 1980s do not contradict the new results.

Key words: stochastic electrodynamics, zero-point radiation, hydrogen atom.

1. INTRODUCTION

Cole and Zou’s recent article[1], “Quantum mechanical ground state of hydrogen obtained from classical electrodynamics,” reports a computer-simulation calculation of the ground state of hydrogen using classical electromagnetic interactions for a point charge in a Coulomb potential experiencing both radiation reaction forces and the random forces of zero-point radiation. Their work suggests that the problem of atomic collapse within classical physics has probably been solved.

Ever since the acceptance of Rutherford’s nuclear model of the atom, classical physics has confronted the problem of atomic collapse[2], the loss of radiation energy by an orbiting electron and the subsequent collapse of the electron into the nucleus. Bohr avoided the problem by an ad hoc change in the foundations of radiation theory; he proposed that in certain stationary states an electron does not
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radiate. Bohr's successful proposal has been transformed into the currently accepted quantum mechanics. However, during the twentieth century, there were occasional suggestions[3] that actually the electron did indeed follow the rules of classical electrodynamics and that atomic collapse did not occur because the electron performed a random walk due to random classical radiation, classical zero-point radiation. The spectrum of zero-point radiation is fixed by the requirements of Lorentz invariance or invariance under adiabatic compression, giving a constant times $\omega$ for the energy per normal mode. The constant is fixed by comparison with van der Waals forces and corresponds to an energy $1/2h\omega$. The hypothesis of classical electromagnetic zero-point radiation is found to give results which agree with quantum calculations for all systems which can be described by electric-dipole harmonic oscillator systems. This includes van der Waals forces, specific heats of solids, diamagnetism, and thermal effects of acceleration through the vacuum. This classical electron theory with its boundary condition changed to include classical electromagnetic zero-point radiation is often termed "stochastic electrodynamics" or "SED"[4].

2. NUMERICAL SIMULATIONS

Classical zero-point radiation does not have a flat (white) spectrum and so leads to a non-Markov process for the charged electromagnetic systems in interaction with this radiation. Only in the limit of small interaction with radiation, charge $e$ goes to 0, do we recover a quasi-Markov process. Although there have been qualitative suggestions that zero-point radiation solves the problem of atomic collapse, the nonlinear, non-Markovian character of the interaction of zero-point radiation with an electron in Coulomb orbit has prevented any credible analytic evaluation. Recently, Daniel Cole and Yi Zou have begun careful, systematic numerical calculations of the classical electromagnetic interactions of a plane wave with a point charge in a Coulomb potential [5]. Their work has been accepted for publication in journals specializing in scientific computing. The numerical simulations, which include radiation reaction, show certain resonant- and jump-like behaviors for this nonlinear system which have never before been mentioned in the literature.

In their recent article[1], Cole and Zou continue their numerical calculations of a point charge in a Coulomb potential including radiation reaction. This time they treat interaction with a simulated zero-point radiation spectrum. Their conclusion is that the electron does not collapse into the center of the potential nor is it ejected to infinity (ionized). There seems to be an equilibrium radial probability distribution. Indeed, this radial distribution seems to approximate the distribution predicted by the Schrödinger equation for the hydrogen ground state. This seems a remarkable result. It is clear that the cal-