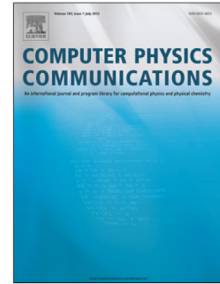


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A Unified Hamiltonian Solution to Maxwell-Schrödinger Equations for Modeling Electromagnetic Field-Particle Interaction

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Abstract

A novel unified Hamiltonian approach is proposed to solve Maxwell-Schrödinger equation for modeling the interaction between classical electromagnetic (EM) fields and particles. Based on the Hamiltonian of electromagnetics and quantum mechanics, a unified Maxwell-Schrödinger system is derived by the variational principle. The coupled system is well-posed and symplectic, which ensures energy conserving property during the time evolution. However, due to the disparity of wavelengths of EM waves and that of electron waves, a numerical implementation of the finite-difference time-domain (FDTD) method to the multiscale coupled system is extremely challenging. To overcome this difficulty, a reduced eigenmode expansion technique is first applied to represent the wave function of the particle. Then, a set of ordinary differential equations (ODEs) governing the time evolution of the slowly-varying expansion coefficients are derived to replace the original Schrödinger equation. Finally, Maxwell's equations represented by the vector potential with a Coulomb

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