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Title:Parallel Implication of 3-D FDTD Method in a Four-level Atomic System
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Abstract:A parallel scheme is presented to model the interactions of light with active materials or gain materials, represented by a four-level atomic system, using 3-D finite-difference time-domain method incorporated with auxiliary differential equation method. It tracks fields and population densities at each spatial point, taking energy exchange between atoms and fields, electronic pumping, and non-radiative decays into account. The validity of the method is demonstrated with a homogenous gain material slab. Transmission, reflection, and absorption data as well as the retrieved effective parameters are also presented for a split ring resonators embedded in gain materials, and the results further demonstrate the efficiency of the proposed model in metamaterials simulations. Our results can be used as an instruction for the real pump-probe experiments in metamaterials, and provide a deep insight into the dynamic interaction between nanostructure and gain materials.
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Inspec controlled terms:atom optics - atom-photon collisions - differential equations - finite difference time-domain analysis - laser cavity resonators - metamaterials - microwave photonics - nanophotonics - nanostructured materials - optical pumping - terahertz wave spectra
Uncontrolled terms:parallel implication - 3D FDTD Method - four-level atomic system - light interactions - active materials - 3D finite-difference time-domain method - auxiliary differential equation method - population densities - field densities - spatial point - energy exchange - electronic pumping - nonradiative decays - homogenous gain material slab - transmission data - absorption data - reflection data - embedded split ring resonators - metamaterial simulations - real pump-probe experiments - dynamic interaction - nanostructure
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