Coherent Vector π Pulse in Optical Amplifiers

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We investigated the amplification and propagation of the short electromagnetic solitary waves in a linearly birefringent and dispersive optical fiber containing resonant atoms with an inverted population of the energy levels. The resonant medium model involved two-level atoms, with an upper state that is degenerate on the projection of the angular moment. In the case of an isotropic fiber and when GVD can be neglected, we obtained an analytic vector generalization of the scalar π-pulse of light which results from the balance between linear absorption of the host fiber and nonlinear amplification by the active atoms. The polarization state of the solitary wave reflects the specific properties of the resonant atomic system, as well as the polarization of the pump wave. A peculiar property of the linearly polarized vector solution is that after the interaction with the optical pulse the atomic inversion does not vanish, that is the pulse does not leave the atoms in their ground state. We further investigated and confirmed by means of simulations the robustness of the linearly polarized vector π pulse in the presence of both birefringence and dispersion of the host fiber. Moreover, we numerically observed that a weak incident pulse of arbitrary polarization is amplified until it is transformed into a stable vector π pulse without a change of its initial polarization state.