Numerical simulation of laser pulse amplification in four-level medium by using Maxwell-Bloch equations

Kuzmin I.V.[1,@]

[1] Institute of Applied Physics of the Russian Academy of Sciences, Ulyanova 46, Nizhny Novgorod, 603950, None

[@] kuzminiv@ipfran.ru

Typically, a system of balance equations is used to describe the operation of solid-state laser pulse amplifiers [1].However, under conditions of inhomogeneous lasing line broadening, gain saturation effects and dependence of the medium polarisation on the population inversion value, this approach is clearly insufficient. In this case, it is necessary to use a model based on the semi-classical Maxwell-Bloch equations [2,3]. An active medium with inhomogeneous broadening of the lasing line is described by a system of Bloch equations, which relate the dynamics of populations at the corresponding energy level to the dynamics of partial polarisations under the influence of signal and pump fields. The propagation of laser radiation in a medium can be described by the Unidirectional Propagation Equation (UPPE). Numerical simulation results of the proposed system of equations for a four-level medium are presented in this paper. The features of the formation of an electron lens under longitudinal pumping under conditions of gain saturation and inhomogeneous lasing line broadening during amplification of broadband chirped laser pulses are shown.

This work is supported by the Ministry of Science and Higher Education of the Russian Federation (Project No. FFUF-2024-0038)

[1] Gacheva E I, Zelenogorskii V V, Andrianov A V, Krasilnikov M, Martyanov M A, Mironov S Y, Potemkin A K, Syresin E M, Stephan F and Khazanov E A 2015 *Optics Express* **23** 9627

[2] Kocharovsky V V, Zheleznyakov V V, Kocharovskaya E R and Kocharovsky V V 2017 *Physics-Uspekhi* **60** 345–384

[3] Chang S H and Taflove A 2004 *Optics Express* **12** 3827