A VLASOV CODE SIMULATION OF PLASMA-BASED BACKWARD RAMAN AMPLIFICATION IN UNDERDENSE PLASMAS

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We use an Eulerian Vlasov code to study the problem of the plasma-based backward Raman amplification in underdense plasmas. The code solves the one-dimensional Vlasov-Maxwell set of equations [1,2]. This allows the inclusion of kinetic effects such as particle heating and trapping, in the amplification of an ultrashort seed laser pulse by a long pump laser pulse in an underdense plasma. The process of energy transfer from the pump to the seed is mediated by the ponderomotive beat-driven resonant plasma wave in the stimulated Raman backscattering instability [3]. In the example we study, we use parameters close to what is presented in [4]. The wavelength of the pump beam is \( \lambda_{\text{pp}} = 1.05 \mu m \), and its normalized vector potential is \( a_0 = 0.04 \). The ratio of the pump frequency to the plasma frequency is \( \omega_{\text{pp}} / \omega_{\text{pe}} = 3.180 \) (corresponding to \( n / n_c \approx 0.099 \), where \( n_c \) is the critical density). The seed pulse has a frequency \( \omega_{\text{sp}} / \omega_{\text{pe}} = 2.1657 \) and a wavelength \( \lambda_{\text{sp}} = 1.541 \mu m \), resonating with the pump and the plasma wave, and a Gaussian shape of width \( \tau_\omega \omega_{\text{sp}} = 19.7 \). The length of the initially uniform plasma system is \( L_p = 600c / \omega_{\text{pe}} \sim 189c / \omega_{\text{pp}} \), with an initial temperature \( T_e \approx 200eV \). The interaction over this length of the plasma leads to an amplification of the seed amplitude by a factor close to 30. A fine numerical resolution in phase-space is used to resolve the kinetic effects and the details of the distribution function with the precision of the Vlasov code.

References