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Study of nonlinear Landau damping in backward Raman amplifier

NIKOLAI YAMPOLSKY, NATHANIEL FISCH, PPPL — A plasma wave mediates laser coupling in a plasma-based resonant backward Raman amplifier/compressor (BRA) for high power amplification of short laser pulses. The resonant nature of amplification requires long lifetime of the plasma wave. However, the plasma wave can be heavily Landau damped in warm plasma. On the other hand, Landau damping can be saturated in the presence of strong plasma wave. First, we develop a simplified model of nonlinear Landau damping which describes this kinetic phenomenon in terms of fluid equations. We verify the simplified fluid model numerically and show that it has about 90% accuracy within its applicability limits. This model can be applied to the BRA problem and a semi-analytical solution can be found. We find the regime of amplification in which the originally large Landau damping can be significantly reduced during the interaction. In this a regime BRA can occur at higher plasma temperatures than would be calculated from a purely linear theory. This work supported by the NNSA and by DOE Contract DE-AC02-76CH03073.

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