Hybrid SRS-TPD instability in inhomogeneous femtosecond laser plasma

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Electron acceleration in femtosecond laser plasma with scalelength $L/\lambda\sim1$ is due to nonlinear plasma wave excitation [1]. Optimization of high energy electrons generation requires study of nonlinear laser-plasma interaction and wave excitation. Radiation scattered by waves carries information about their frequencies, wave numbers and space localization and can be used for plasma wave diagnostics. Studies of instability in femtosecond plasma have already been carried out in papers [2,3], a feature of this work is the short plasma gradient ($L/\lambda\sim1$) and subrelativistic intensities of the laser pulse.

The PIC simulation showed that the main feature of the oblique incidence laser pulse interaction with short plasma gradient is refraction, which leads to the appearance of new components in the spatial spectrum. So, the instability pump wave should now be considered as a sum of plane waves, and this leads to the appearance of new features for instability growth rate. The analysis of electromagnetic fields showed that in addition to the electrostatic component in the ponderomotive forces corresponding to the TPD, there is an electromagnetic component corresponding to SRS. SRS and TPD have a common plasma wave. This agrees with the observed values of the plasmon wave vector $k_x=1.1\text{-}1.6k_0$ [4] The scattering of the fundamental wave by plasma generates a radiation source with an even broader spectral k_y component and a rather narrow k_x component, which determines the angular distributions of the scattered radiation at frequencies $3/2\omega$ and $1/2\omega$. The angular distributions of $3/2\omega$ radiation from PIC simulation are in good agreement with the experimental data.

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