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Simulation study of parametric instabilities at intensities relevant to shock ignition

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Shock Ignition (SI) has been proposed as a relatively robust way of achieving efficient fuel burn in the inertial confinement fusion. The shock is launched at the end of the compression phase by increasing the laser power to several hundreds of TW. The possibility of efficient absorption of the ignition pulse with sufficient energy conversion to the shock wave remains an open question. At the assumed intensities of ~10^{16} W/cm^2 nonlinear phenomena in the laser interaction with large scale corona, which may undermine the SI efficiency, cannot be avoided.

The interaction of laser ignition pulse with large scale hot plasma is investigated here via fully kinetic simulations in one-dimensional planar geometry. Our simulations demonstrate that such plasma could provide an efficient collisionless absorption of high intensity laser radiation. The laser energy is absorbed in density cavities that are created and maintained by two coupled SRS processes forming a self-organized resonator between the zones of 1/4th and 1/16th of the critical density. This particular plasma response is due to the high initial plasma temperature that suppresses the SRS development everywhere in plasma with exception of the resonant point where SRS is growing as an absolute parametric instability and it is accompanied by efficient laser energy conversion in the flux of moderately energetic electrons.

The absorption process and the spectrum of the reflected light are studied in dependence on the ignition laser pulse intensity in the range 10^{15}–10^{16} W/cm^2. The initial plasma conditions come from hydrodynamic simulations and they correspond to the latest LLE shock ignition experiment performed at Omega laser facility. Preliminary results indicate a good agreement of our simulations with the LLE experiments and also favorable conditions for the shock ignition scenario. Namely, the large absorption coefficient exceeding 70% and a Maxwellian spectrum of hot electrons with a temperature of about 30 keV are well suited for the creation of the ignition shock wave.