Modeling parametric instabilities in the corona of direct-drive targets

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The understanding of laser-plasma parametric instabilities (LPI) in a realistic large-scale speckle field involving several laser beams is a long-standing issue (see e.g. [1]) which has sparked numerous studies, both on the theoretical [1, 2, 3] and experimental side [4, 5]. Yet, limited computational capabilities have so far limited modeling efforts to either a very limited plasma size or strongly simplified models. It is only quite recently with the advent of large-scale supercomputers that the first simulations of LPI produced by a realistic speckle field inside a holhraum plasma were carried out [6].

Here, we will focus our efforts on direct-drive physics in the presence of several laser beams. The problem of LPI modeling in this setting is even more challenging since the characteristic scales of the problem span from the long density gradient length scale on one end, down to the numerous wave-length sized laser speckles [7] on the other. We aim here at describing the physics of LPI on the scale of a single speckle as well as the probable collective interaction among a large set of narrowly spaced speckles. Advances in the understanding of these phenomena is of primary importance in the assessment of beam smoothing techniques for instance.

Evidently, the continuity of physical scales forbids any *a priori* simplification of the model involving spatial scales separation. We approach this problem on two sides : first, using a few numerically demanding 2D full scale PIC simulations, we describe the growth and propagation of LPI in the speckle field. Such simulations include all the physics relevant to the problem which we aim then at capturing using a second reduced model (also 2D) based on Zakharov equations [2]. On the contrary to earlier attempts, we do not rely here on the paraxial approximation and thus we are able to describe any speckle field of interest. Yet, since Zakharov equations derivation involves relying on a fluid description of electrons, kinetic effects are absent of this model. In the long run, we aim at pursuing earlier efforts published in the literature [3] at introducing kinetic effects also in this second model, based on evidence obtained from PIC simulations.

First steps in this study including PIC simulations and the first results obtained from the reduced model will be presented.

References

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