TOWARD THE DYNAMICAL MODELIZATION OF SELF-ORGANIZED PLASMA FORMATION IN SOLIDS

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Interaction between intense illumination and matter now reaches beyond the well understood nonlinear perturbative optics. Entering the extreme nonlinear optics regime, ionization mechanisms and ion-electron interaction must be considered to describe phenomena such as plasma formation, laser ablation or high harmonic generation (HHG). A considerable amount of work has been done in the case of laser-gas interactions both theoretically and experimentally. In constrast, for laser-solid interactions, the problem is even more complex, fewer results are available, and much is still to be explored.

Extreme nonlinear optics in solids is a relatively new research area with rapidly growing interest. We wish to examine two of its possible applications : laser ablation for micromachining, and solid state HHG. Whereas the latter has lately seen remarkable experimental breakthroughs,[1] it is safe to say that a general theoretical explanation is still lacking. As to the former application, the theory stands on firmer ground and we have recently extended the best available model which include the self-organization and the growth of surface nanostructures over several laser pulses.[2]

To improve upon our theoretical understanding, we are adapting the numerical method of Particle-In-Cells (PIC) to account for the optical response of solid materials. While the PIC models are already well suited for laser-plasma interaction,[3] an additional coupling to the ionization mechanisms allows us to simulate the self-organization of the plasma during the early stages of its formation. Moreover, we will discuss the possibility to adapt this framework and numerical tool to model radiation processes in solid-density plasmas. Results of our simulations on both of the aforementioned applications will be presented at the conference.

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