DPP06-2006-000116

Abstract for an Invited Paper
for the DPP06 Meeting of
the American Physical Society

Dynamics and control of the expansion of finite-size plasmas produced in ultraintense laser-matter interactions

FABIO PEANO, GoLP/Centro de Fisica dos Plasmas, Instituto Superior Tecnico, Lisboa, Portugal and Dipartimento di Energetica, Politecnico di Torino, Torino, Italy

The expansion dynamics of nanometer-sized plasmas is a key issue for applications involving the interaction of ultraintense infrared laser pulses with cluster jets [1], or the irradiation of biological samples with ultraintense x-ray pulses, for biomolecular imaging purposes [2]. Typically, these scenarios involve the prompt formation and expansion of dense plasmas, composed of cold ions and hot electrons. Control over the expansion can be achieved by exploiting the role of the electron dynamics: in particular, using suitable sequences of laser pulses, one can tailor the phase-space dynamics of the ions [3]. This provides the ability to generate large-scale shock shells [4], and opens the way towards intracluster fusion reactions within large D or D-T clusters [3]. Such new possibilities urge the need for a deeper comprehension of the expansion process, in regimes far from that of a pure Coulomb explosion. To this end, a novel Lagrangian model is used, which provides a self-consistent, kinetic description of the collisionless expansion of spherical nanoplasmas: simple relationships are deduced for the key expansion features, valid for a wide range of initial conditions [5], and a threshold in the electron energy is identified, beyond which the energy spectrum becomes monotonic and the Coulomb explosion regime is approached.

[1] T. Ditmire *et al.*, Nature **386**, 54 (1997); T. Ditmire *et al.*, Nature **398**, 489 (1999).
[2] R. Neutze *et al.*, Nature **406**, 752 (2000); H. Wabnitz *et al.*, Nature **420**, 482 (2002).
[3] F. Peano *et al.*, Phys. Rev. Lett. **94**, 033401 (2005); Phys. Rev. A, **73** , 053202 (2006).
[4] A. E. Kaplan *et al.*, Phys. Rev. Lett. **91**, 143401 (2003)
[5] F. Peano *et al.*, Phys. Rev. Lett. **96**, 175002 (2006).