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Explosion of laser-irradiated micro-clusters

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Abstract

This work has been motivated by desktop laser fusion experiments, in which fusion reactions were produced by the irradiation of deuterium micro-clusters with a very short laser beam [1]. The observed phenomenon is associated with ion acceleration in the process of cluster explosion. There are two conceivable scenarios for such an explosion: an electrical and a thermal one. Although both scenarios involve the space-charge electric field as an accelerating force for the ions, the essential difference between the two is that the thermal scenario preserves quasi-neutrality whereas the electrical scenario does not. The choice between these two scenarios depends on how the cluster electrons respond to the laser field. There is a natural trend for the electron population to have a two-components distribution function [2]: a cold core that responds to the laser field adiabatically and a halo that undergoes stochastic heating [3].

We have carried out 2D PIC simulations to study the explosion of a single filament-like cluster. The simulations confirm the development of a two-component electron distribution in the expected parameter range. We also find that the explosion scenario (electrical vs. thermal) affects the symmetry of the ion expansion. In the electrical scenario, the asymmetry is caused by the cold electron core oscillations inside the cluster in the direction of the laser field. The cluster expansion in the direction of the laser field is therefore somewhat suppressed and the cluster expands primarily in the plane perpendicular to the laser field. In contrast, in the thermal scenario, electron pressure is anisotropic, with a typically larger pressure along the laser electric field. As a result, the ions expand predominantly along the electric field. A new code is being developed to simulate expansion of axisymmetric 3D clusters to allow quantitative comparison with experimental results.

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[1] T. Ditmire, J. Zweiback, V.P. Yanovsky, T.E. Cowan, G. Hays, and K.B. Wharton, Nature **398**, 489 (1999).
[2] B. Breizman and A. Arefiev, IFS report-950 (To be published in Plasma Physics Reports) http://peaches.ph.utexas.edu/ifs/ifsreports/950_Breizman.pdf
[3] F. Brunel, Phys. Rev. Lett. **59**, 52 (1987).