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Multi-species and kinetic effects in ICF plasmas[1]

CLAUDIO BELLEI, Lawrence Livermore National Laboratory

Traditionally, numerical codes that are used in the ICF community treat the plasma as an average-species fluid, neglecting the presence of multiple ion species, self-consistent electric (and magnetic) fields and kinetic effects. As compute power increases, multi-species, collisional particle-in-cell simulations of dense fusion plasmas are now becoming feasible. These simulations reveal rich and complex physics that has so far been mostly unexplored in the context of ICF implosions. This talk will present highly detailed simulations that push the boundary of conventional ICF modeling. In particular, we will show how gradients in pressure, temperature and electrostatic potential can lead to appreciable ion species separation as the ion-ion mean free paths increase during convergence of the spherical shock in the inner gas of an ICF capsule [1,2]. The effects of species separation on fusion yield in ICF targets will be discussed. In addition, a kinetic description of the shock physics reveals characteristics of a weakly collisional system, including ion diffusion across the shock and reflection of the upstream ions at the shock front [3]. When these (strong) shocks propagate across an interface that separates different materials (such as an ablator-gas interface), they can push a fraction of the ions from the ablator into the gas, enhancing mix. How this mix influences neutron yield will be examined.

[1] P. A. Amendt, S. C. Wilks, C. Bellei, et al., Physics of Plasmas 18, 056308 (2011);
[2] C. Bellei, P. A. Amendt, S. C. Wilks, et al., Physics of Plasmas 20, 012701 (2013);
[3] C. Bellei, P. A. Amendt, S. C. Wilks, et al., Physics of Plasmas 20, 044702 (2013).

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