DPP13-2013-001292

Abstract for an Invited Paper
for the DPP13 Meeting of
the American Physical Society

Theory of Hydro-Equivalent Ignition for Inertial Fusion and Its Applications to OMEGA and the NIF

R. NORA, Fusion Science Center, Laboratory for Laser Energetics, and Dept. of Physics, U. of Rochester

The theory of ignition for inertial confinement fusion (ICF) capsules[1] is applied to current cryogenic implosion experiments on the National Ignition Facility (NIF) and Omega Laser Facility. When applied to the NIF indirect-drive experiments at 1.4 to 1.6 MJ of laser energies, the Lawson product of the pressure and confinement time $P\tau$ is about 10 to 18 atm s—about half of that required for ignition at ∼5-keV temperature. For the latest OMEGA direct-drive–implosion experiments, $P\tau$ is about 3 atm s. The Lawson parameter $P\tau$ is computed in three different ways: (1) Using the theory of Betti *et al.*;[2] (2) the measured neutron yield and x-ray images of the imploded capsules; and (3) direct 2-D simulations that reproduce all the measured stagnation quantities (such as ion temperature, areal density, x-ray images, burn history, and neutron yield). In this paper, the theory of hydrodynamic similarity is developed in both 1-D and 2-D, and tested using multimode hydrodynamic simulations with code *DRACO*[3] of hydro-equivalent implosions (implosions with the same implosion velocity, adiabat, and laser intensity). The theory is used to scale the performance of OMEGA implosions to the NIF energies and determine the requirements for hydro-equivalent ignition. Hydro-equivalent ignition on OMEGA is represented by a cryogenic implosion that would scale to ignition on the NIF at 1.8 MJ of symmetric laser energy. It is found that a reasonable combination of neutron yield and areal density for OMEGA hydro-equivalent ignition is $\sim 4 \times 10^{13}$ and ~ 0.3 g/cm^2. This performance has not yet been achieved on OMEGA. This work is supported by the Department of Energy National Nuclear Security Administration under Award Number DE-NA0001944.

[1]R. Betti *et al.*, Phys. Plasmas **17**, 058102 (2010).
[2]Betti, Phys. Plasmas **17** 058102
[3]P. B. Radha *et al.*, Phys. Plasmas **12**, 032702 (2005).