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Ion Kinetic Dynamics in Strongly-Shocked Plasmas Relevant to ICF

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Implosions of thin-shell capsules produce strongly-shocked ($M > 10$), low-density (ρ ˜ 1 mg/cc), high-temperature (T_i ˜ keV) plasmas, comparable to those produced in the strongly-shocked DT-vapor in inertial confinement fusion (ICF) experiments. A series of thin-glass targets was filled with mixtures of deuterium and Helium-3 gas ranging from 20% to 100% deuterium and imploded on the OMEGA laser at the Laboratory for Laser Energetics to investigate the impact of multi-species ion kinetic mechanisms on ICF-relevant plasmas. Anomalous trends in nuclear yields and burn-averaged ion temperatures, which have been interpreted as signatures of ion species separation and ion thermal decoupling [H. G. Rinderknecht et al., Phys. Rev. Lett. 114, 025001 (2015)], are found not to be consistent with single-species ion kinetic effects alone. Experimentally-inferred Knudsen numbers predict an opposite yield and temperature trend to those observed, confirming the dominance of multi-species physics in these experiments. Ion density is inferred to be half of the predicted value: models of undercompression and loss of ions at the fuel/ablator interface are considered. The impact of the observed kinetic physics mechanisms on the formation of the hotspot in ICF experiments is discussed.

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