DPP16-2016-001684

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Ultrafast visualization of the structural evolution of dense hydrogen towards warm dense matter[1]

LUKE FLETCHER, SLAC National Accelerator Laboratory

Hot dense hydrogen far from equilibrium is ubiquitous in nature occurring during some of the most violent and least understood events in our universe such as during star formation, supernova explosions, and the creation of cosmic rays. It is also a state of matter important for applications in inertial confinement fusion research and in laser particle acceleration. Rapid progress occurred in recent years characterizing the high-pressure structural properties of dense hydrogen under static or dynamic compression. Here, we show that spectrally and angularly resolved x-ray scattering measure the thermodynamic properties of dense hydrogen and resolve the ultrafast evolution and relaxation towards thermodynamic equilibrium. These studies apply ultra-bright x-ray pulses from the Linac Coherent Light (LCLS) source. The interaction of rapidly heated cryogenic hydrogen with a high-peak power optical laser is visualized with intense LCLS x-ray pulses in a high-repetition rate pump-probe setting. We demonstrate that electron-ion coupling is affected by the small number of particles in the Debye screening cloud resulting in much slower ion temperature equilibration than predicted by standard theory.

[1]This work was supported by the DOE Office of Science, Fusion Energy Science under FWP 100182