MEASUREMENTS OF CHARGED-PARTICLE STOPPING POWER IN WARM-DENSE PLASMA AT OMEGA AND THE NIF

A.B. Zylstra[1], J.A. Frenje[1], P.E. Grabowski[2], J.R. Rygg[3], C.K. Li[1], G.W. Collins[3], P. Fitzsimmons[4], S. Glenzer[5], F. Graziani[3], S.B. Hansen[6], S.X. Hu[7], M. Gatu Johnson[1], P. Keiter[8], H. Reynolds[4], F.H. Séguin[1], R.D. Petrasso[1]
[1]Plasma Science and Fusion Center, Massachusetts Institute of Technology, Cambridge, MA 02139, USA
[2]University of California Irvine, Irvine, CA 92697, USA
[3]Lawrence Livermore National Laboratory, Livermore, CA 94550, USA
[4]General Atomics, San Diego, CA 92186, USA
[5]SLAC National Accelerator Laboratory, Menlo Park, CA 94025, USA
[6]Sandia National Laboratories, Albuquerque, NM 87185, USA
[7]Laboratory for Laser Energetics, University of Rochester, Rochester, NY 14623, USA
[8]University of Michigan, Ann Arbor, MI 48109, USA
Email: azylstra@psfc.mit.edu

The stopping power of energetic protons has been measured in an isochorically-heated solid-density Be plasma with an electron temperature of ~32 eV, corresponding to moderately-coupled [$(e^2/a)/(k_BT_e + E_F) \sim 0.3$] and moderately-degenerate [$k_BT_e/E_F \sim 2$] 'warm dense matter' (WDM) conditions. We present the first high-accuracy measurements of charged-particle energy loss through a WDM plasma, which shows an increased loss relative to cold matter. The data agree with stopping models based on an ad-hoc treatment of free and bound electrons [1], as well as the average-atom local-density approximation [2]; this work is the first high-precision experimental test of these theories for WDM plasma conditions. Using a Bethe-style stopping equation the data can also be used to calculate a mean ionization potential, which decreases in the WDM plasma in good agreement with theoretical values from electronic structure models. This work can be extended to fully-degenerate and moderately-coupled plasmas by using shock compression; the design of an upcoming experiment on NIF using shock-compressed HDC probed by D^3He protons is discussed.

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