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Observation and control of shock waves in individual nanoplasmas DANIEL D. HICKSTEIN, FRANKLIN DOLLAR, WEI XIONG, K. ELLEN KEISTER, JENNIFER L. ELLIS, CHENGYUAN DING, HENRY C. KAPTEYN, MARGARET M. MURNANE, JILA - University of Colorado, JIM A. GAFFNEY, MARK E. FOORD, STEPHEN B. LIBBY, Lawrence Livermore National Laboratory, BRETT B. PALM, JOSE L. JIMENEZ, Dept. of Chemistry, University of Colorado, GEORGE M. PETROV, Naval Research Laboratory — Using short (40 fs) laser pulses at an intensity of 10^{14} W/cm^2, we present the first observation of shock waves in nanometer-scale plasmas (nanoplasmas). Nanoplasmas offer enhanced laser absorption compared to either solid or gas targets, and the generation of shock waves presents an appealing method for creating new sources of monoenergetic ions and X-rays from a tabletop scale apparatus. By utilizing an instrument that images photoions from a single nanoparticle, we make the first experimental observation of individual nanoplasmas and observe clear shock waves. We demonstrate that the introduction of a heating pulse prior to the main laser pulse increases the intensity of the shock wave, and produces a strong burst of quasi-monochromatic ions with energies around 100 eV. Numerical hydrodynamic calculations show that the energy of the quasi-monochromatic ions increases with the intensity of the driving laser, suggesting a possible avenue for production of higher-energy monoenergetic ions required for medical applications. Additionally, this observation of well-characterized shock waves in dense, low-temperature plasmas may enable the laboratory control, study, and exploitation of nanoscale shock phenomena with tabletop lasers.

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