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X-ray scattering measurements of ionization in shock-compressed deuterium PAUL DAVIS, University of California, Berkeley — The physical properties of hydrogen at extreme conditions play an important role in our understanding of high-pressure phase transitions, the structure of giant planets and the dynamics of inertial fusion. We report the first microscopic measurements of ionization in dynamically compressed hydrogen. Cryogenic targets were shock-compressed to several times liquid density using a high power laser. An intense burst of 2 keV x-rays was generated using a second laser pulse, probing the dense shock-front. By collecting and spectrally dispersing scattered radiation in both forward and backward directions, we measured collective plasmon oscillations and the Fermi distribution of the electrons freed in the compression process. Combined with velocity interferometry to diagnose shock velocity, we infer a sharp onset of ionization at 3 times compression. These results offer an important new basis for comparison with the many competing theories of high-pressure hydrogen. In particular, comparison with finite temperature quantum molecular dynamics simulations suggests a close relationship between ionization and molecular dissociation.

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