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Dense plasma physics accessible experimentally via new, pulsed x-ray probing techniques.[1]

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We have developed accurate x-ray scattering techniques to measure the physical properties of dense matter produced in high-energy density physics experiments. Powerful penetrating x-ray sources are employed to probe these short-lived hot dense states of matter with electron densities in the range of solid density and higher. The back-scattering spectrum accesses the non-collective Compton scattering regime, which provides accurate diagnostic information on the temperature, density and ionization states. The forward scattering spectrum has been shown to measure the collective plasmon oscillations. Besides extracting the standard plasma parameters, density and temperature, forward scattering yields new observables such as a direct measure of collisions, quantum effects and structure factors. In this talk, experiments on shock-compressed matter will be presented that have demonstrated the direct measurement of compression and heating. In addition ultra-fast scattering measurements with K-alpha x rays are presented that probe conditions in coalescing shocks with 10 ps temporal resolution. These data test the radiation-hydrodynamic modeling of shock-compressed dense matter and can be further developed to measure the equation of state at high pressures.

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