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X-ray Radiography and Scattering Diagnosis of Dense Shock-Compressed Matter

SEBASTIEN LEPAPE, Lawrence Livermore National Laboratory

Spectrally resolved x-ray Thomson scattering is an established technique that allows characterizing Fermi degenerate dense plasmas accessible in laser shocked-compressed foil experiments. It has been used in a variety of experiments that, besides measuring plasma density and temperature, served as critical test for models that calculate important plasma parameters like structure factors, bound-free contributions, and ionization energy lowering in warm dense matter. Experiments realized at the TITAN facility at Lawrence Livermore National Laboratory apply ultra-short pulse laser produced K- x rays to characterize plasmas at pressures above 1.5 Mbar that are produced with an energetic nanosecond laser. High energy x-rays produced by the short pulse laser allow probing compressed matter with a high temporal resolution (about 10 ps). From collective and non-collective scattering spectra mass density of the compressed Boron is inferred. X-ray radiography has been used as an independent way to characterize the mass density of matter for identical drive conditions. Here, we use K-X rays in a point projection scheme to probe the shock wave. Densities ranging from 3 to 4 g/cc have been measured, in excellent agreement with the x-ray Thomson scattering data. These radiography data combined with accurate measurement of the Plasmon dispersion in shocked Boron help improving the accuracy of the collision model as well as structure factor calculation.