CFEL SCIENCE

SEMINAR

15th July 2011 - 11:00

Building 49 - Seminar Room 108

Carsten Fortmann

Lawrence Livermore National Laboratory, Livermore, CA 94551

X-ray scattering diagnostics of shock compressed coulomb systems

Shock-compression of solid density targets produces matter under extreme conditions of density, pressure and temperature for inertial confinement fusion research and laboratory astrophysics. Super high densities beyond the single-shock limit are reached through interaction of multiple strong shocks. Determining the space and time resolved physical parameters in the strongly coupled shock compressed matter is a challenge for both theoretical and experimental researchers. Spectrally resolved x-ray scattering of multi keV photons delivered from plasma x-ray sources and free electron lasers has become a standard plasma diagnostic method. X-rays penetrate deep into the plasma providing an in-situ method to probe the bulk properties of these short-lived states of hot and dense matter. Under large scattering angles, the non-collective Compton scattering component yields an accurate measurement of the electron density and temperature. Under small angles, one observes collective plasmon excitations that depend on the electron-ion collisionality and local field effects. The quasi-elastic ion feature reflects the ion-ion structure factor, its total intensity scales with the average ionization. We report on recent theoretical development and experimental applications of x-ray Thomson scattering to investigate the dynamic and static properties of shock-compressed matter. We present a first x-ray scattering experiment performed on counter-propagating shocks colliding in a beryllium target. This technique is shown to compress matter at low entropy increase. Using the Hugoniot relations for colliding shocks, we derive the heat capacity ratio $\gamma = c_p/c_v$ as a function of density and compare the equation of state models.

[1] T. Neal, in *High-Pressure Science and Technology*, AIRAP Conference Proceedings, Vol.1 and 2, edited by K. D. Timmerhaus and M. S. Barber (Plenum Press, New York, 1979)

[2] D. Froula, S. Glenzer, N. Luhmann, and J. Sheffield, *Plasma Scattering of Electromagnetic Radiation*, 1st ed. (Academic Press, San Diego, 2011)

[3] C. Fortmann, H. J. Lee, T. Döppner, R. W. Falcone, A. L. Kritcher, O. L. Landen, and S. H. Glenzer, Phys. Rev. Lett. (submitted)(2011)

Host: Beata Ziaja-Motyka – CFEL Theory Group