LABORATORY-PRODUCED X-RAY PHOTOIONIZED PLASMAS FOR ASTROPHYSICS EXPLORATION

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X-ray photoionized plasmas are rare in the laboratory, but of broad importance in astrophysical objects such as active galactic nuclei, x-ray binaries [1]. Understanding their spectroscopic properties would improve interpretation of X-ray spectra collected by telescopes such as NASA's Chandra X-Ray Observatory by constraining atomic models. Indeed, existing models are not yet able to accurately describe these plasmas where ionization is driven by radiation rather than electron collisions.

Creating photoionized plasmas in a laboratory is difficult because it requires low-density plasma (< 10^{19} ions/cm^3) and bright X-ray sources (~10^{12} W/cm^2 at the plasma location for photoionization to dominate over collisional processes. There are currently two approaches to obtaining bright X-ray sources that are complementary: one is using the Z facility and the other is relying on a laser-heated hohlraum [2].

Here, we describe an experiment on the LULI2000 facility whose versatility allows for measuring the X-ray absorption of the plasma while independently probing its electron density and temperature. The bright X-ray source is created by the two main beams (350 J, @ 0.53 μm) focused inside a gold hohlraum and is used to photoionise a 10^{18} ions/cm^3 Neon gas jet. Then, a thin gold foil irradiated by a 50 J beam (@ 1.05 μm) serves as a source of backlit photons for absorption spectroscopy. X-rays from the foil are collected by a crystal spectrometer measuring simultaneously the spectra from the backlighter and the transmission through the plasma [3].

The radiation temperature of the hohlraum is measured experimentally using shock velocity at the output of the cavity [4] and the time duration of both X-ray sources is controlled on each shot with fast X-ray photodiodes. The gas jet density is monitored locally by means of streaked Thomson scattering measurements and globally with interferometry. The electron temperature of the plasma is obtained from the transmitted spectra and Thomson scattering measurements.

We will present the experimental setup with state of the art diagnostics to characterize both plasma conditions and X-ray emission. Then we will show the transmitted spectra through the plasma to observe the transition from collision dominated to radiation dominated ionization and compare it to model predictions. This work was performed under the auspices of the U.S.Department of Energy by Lawrence Livermore National Laboratory under Contract No. DE-AC52-07NA27344.

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