Laboratory photoionized plasma experiments relevant for astrophysics

Roberto C. Mancini[1]

[1]Physics Department, University of Nevada, Reno

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Abstract

Many astrophysical environments such as x-ray binaries, active galactic nuclei, and accretion disks of compact objects have photoionized plasmas. These low-density plasmas are driven by an intense, broad-band x-ray flux and, unlike collisionally-driven plasmas, their atomic kinetics is dominated by photoionization and photoexcitation. Detailed x-ray spectral observations performed with the Chandra and XMM-Newton orbiting telescopes provide critical information on the state of the photoionized; however, the complexity of the astrophysical environment makes the spectral analysis challenging. Developments in pulsed-power and high-power laser drivers for performing high-energy density laboratory plasma experiments have led to the availability of powerful x-ray sources that enable the study in the laboratory of photoionized plasmas relevant for astrophysics under well characterized plasma and driver conditions. This is important since astrophysical models to interpret data from photoionized plasmas have been developed from theory and thus laboratory benchmarks provide an important opportunity to test modeling codes. We review present and future opportunities to perform laboratory photoionized plasma experiments and their relevance and connection to astrophysics. We also discuss the requirements of these experiments including hydrodynamic, atomic physics, time-scales and x-ray drive considerations as well as the instrumentation and measurements that can be performed.

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