Testing High Density XSTAR models with Fe Photoionized Plasma Experiments on Z

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The Z-machine at Sandia National Laboratories generates powerful X-ray radiation fluxes. This enables experiments to produce and study macroscopic quantities of matter at extreme conditions. Astronomers use spectra collected with satellite telescopes to construct models for the behavior of accretion powered plasmas around black holes in both active galactic nuclei and X-ray binaries. However, complex models for these radiation dominated non-Local-Thermodynamic-Equilibrium (NLTE) photoionized plasmas are mostly untested with laboratory data. A novel platform developed on the Z-machine for expanding-foil photoionized plasma experiments opens a new regime for benchmark measurements of NLTE photoionized plasmas. The data from these experiments reveal difficulties in modeling both emission intensities and the level of ionization in the plasma. Such data have been a laboratory astrophysics goal for two decades but are even more critical now because of the "Super-Solar" iron abundance problem. Iron abundances inferred from X-ray spectra emitted by photoionized plasma in many accretion disks around black holes appear to contain 5-20 times more iron than the Sun. This contradicts the widely held expectation that most objects in the universe have metallicities that are at most, only slightly larger than Solar. One prevailing theory is that effects of high electron density are not properly accounted for in the models. Reinterpreting astrophysical X-ray spectra with updated high density models resolved some of the discrepancy. However, much of the discrepancy remains along with a key question: do spectral models of photoionized plasmas accurately account for X-ray emission? I will describe my progress in using this dataset to inform the Super-Solar iron abundance problem and discuss the broader potential to evaluate model accuracy.

This work was performed under the U.S. Department of Energy LRGF Contract No. DE-NA0003960, WCAPP Contract Nos. DE-NA0003843 & DE-NA0004149, Sandia Contract No. DENA0003525, LANL contract 89233218CNA000001, and LLNL Contract No. DE-AC52-07NA27344.

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