A benchmark experiment for x-ray emission and temperature diagnostics in accretion-powered photoionized plasmas

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We have developed a highly reproducible platform on the Z facility for the study of photoionized plasmas (G. Loisel et al., PRL 119, (2017)) in the ξ~20-200 erg.cm/s photoionization regime. Absorption and emission spectra were measured down to 5% reproducibility with high spectral resolution making the data suitable to benchmark photoionization and line formation models. These experiments have measured, for the first time in the laboratory, the radiative recombination continuum (RRC) from photoionized plasma that is used by astronomers to determine the temperature of accretion-powered plasmas around compact objects. As an example, the RRC from H- and He-like states in Vela X-1 and Cygnus X-3 has been used to infer 4 - 70 eV temperatures in plasmas around these objects. The combination of moderate temperature with observed high charge states confirms that radiative processes dominate the ionization and spectrum formation in these objects and in the Z experiment. On Z, a careful experiment design was necessary to overcome the harsh environment associated with the MJ-class x-ray source, such that faint RRC emission from H-like to He-like silicon along with the He-like *n*p-1s (up to *n*=14) series could be observed. Simultaneously, the temperature is inferred from the measured absorption spectrum under the partial LTE assumption. This combination provides a unique test on the temperature diagnostic accuracy when potential line blending, line broadening and continuum lowering could affect the slope of the continuum. Sandia National Laboratories is a multimission laboratory managed and operated by NTESS LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. DOE's NNSA under contract DE-NA0003525.