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X-ray absorption spectroscopy of photoionised plasmas at Z[1]

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Photoionised plasmas are found in astrophysical environments such as x-ray binaries, active galactic nuclei, and in the accretion disks of compact objects. The Z facility at Sandia National Laboratories is a powerful source of x-rays that enables us to produce and study in the laboratory photoionised plasmas relevant for astrophysics under well characterized conditions. We discuss an experimental and theory/modeling effort in which the intense x-ray flux emitted at the collapse of a z-pinch experiment conducted at Z is employed to produce a neon photoionized plasma. The broad-band x-ray radiation flux from the z-pinch is used to both create the neon photoionised plasma and provide a source of backlighting photons to study the atomic kinetics through K-shell line absorption spectroscopy. The plasma is contained in a cm-scale gas cell located at about 5 cm from the z-pinch, and the filling pressure is carefully monitored all the way to shot time since it determines the particle number density of the plasma. Time-integrated and gated transmission spectra are recorded with a TREX spectrometer equipped with two elliptically-bent crystals and a set of slits to record up to six spatially-resolved spectra per crystal in the same shot. The spectral resolution is approximately 1000. The transmission data shows line absorption transitions in several ionization stages of neon including Be-, Li-, He- and H-like Ne ions. Detailed modeling calculations of the absorption spectra are used to interpret and model the high-resolution transmission spectra recorded in the Z experiments with the goal of extracting the ion population distribution of the plasma. Furthermore, the analysis of the gated data provides a window into the dynamics of the photoionized plasma. The data analysis is performed with the aid of a novel application of genetic algorithms to plasma spectroscopy.

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