L-Shell Spectroscopic Diagnostics of Radiation from Krypton HED Plasma Sources

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Abstract:
Due to its non-invasive and direct nature, spectroscopic analysis is a practical diagnostic for radiation from various plasma sources. One such source is the dense plasma focus (DPF). An application for this device is the production of neutrons when operated with deuterium. However, recent interest has developed to demonstrate its potential application as a soft X-ray source. In the past, research has been conducted on x-ray emission from noble gases such as Neon and Argon from a DPF, however almost no investigation has been done on higher Z atomic gases. We present one of the first spectroscopic studies of Krypton high energy density plasmas that were produced on a 3 kJ DPF device in Singapore. Spectral data was collected using an x-ray crystal spectrometer with a convex mica crystal. A single slit was placed between the chamber and crystal to provide spatial resolution. In order to identify spectral features, and to obtain a more comprehensive understanding of plasma parameters, a non-local thermodynamic equilibrium (non-LTE) L-shell kinetic model was developed to be used for the analysis of spectroscopic data. It has the capability of incorporating hot electrons, with different electron distribution functions, in order to examine the effects that they have on emission spectra. To further substantiate the validity of this model, it is also benchmarked with data gathered from experiments on the electron beam ion trap (EBIT), at LLNL. This device operates using an almost monoenergetic beam, which is particularly useful in corroborating the predictions of hot electron effects in the model. The data was collected using the EBIT Calorimeter Spectrometer (ECS), which is a highly efficient broadband spectrometer, and one of the prime diagnostics used on EBIT.