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Hybrid-structure atomic models for HED laboratory plasma diagnostics and simulations

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While theoretical atomic physics calculations are well developed for isolated atoms and have been thoroughly benchmarked against low-density laboratory sources such as electron beam ion traps and tokamak plasmas, the high energy density (HED) regime offers significant challenges for atomic physics and spectroscopic modeling. High plasma densities lead to collective effects such as continuum lowering, line broadening, and significant populations in multiply excited atomic states. These effects change the plasma equation of state and the character of emission and absorption spectra and must be accounted for in order to accurately simulate radiative transfer in and apply spectroscopic diagnostics to HED plasmas. Modeling complex mid- and high-Z ions in the HED regime is a particular challenge because exponential growth in accessible configuration space overwhelms the reduction of the Rydberg levels through continuum lowering. This talk will discuss one approach to generating a tractable spectroscopic-quality atomic kinetics model and describe its application to HED laboratory plasmas produced on Sandia's Z facility.

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