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Collisional-Radiative Modelling of Tungsten Plasma

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The Los Alamos suite of atomic physics codes [1], combined with the plasma modelling code ATOMIC [2,3] has been successfully used in a number of applications to understand the properties of local thermodynamic equilibrium (LTE) and nonLTE plasmas. For example, in LTE, the codes have been used to produce opacity tables for the elements hydrogen through zinc for use in astrophysical modelling [4]. Opacity tables for heavier elements, including the lanthanide metals, have also been produced to assist in the interpretation of light curves from neutron star mergers that also produce gravitational wave signatures [5].

For nonLTE plasmas, ATOMIC has been used for many years to contribute to the series of nonLTE workshops [6], in which detailed comparisons have been made between the results from a variety of nonLTE modelling efforts. For example, ATOMIC was used to predict the ionization balance and radiative power loss from tungsten at temperatures of interest to fusion modelling [7]. ATOMIC has also been used to explore the nonLTE effects in tin plasmas of interest to EUV lithography [8].

In this presentation, we briefly describe the capabilities of ATOMIC, using the calculations performed for tungsten plasma modelling as a worked example. We describe the various types of atomic data that may be used in collisional-radiative modelling. We discuss the difficult problem of ensuring completeness with respect to the number of configurations included in a CR calculation. We also provide a short overview of the opacity-generating capabilities of ATOMIC that may be of interest to the opacity needs of vapor shielding modelling efforts.

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