Accommodating uncertainty in ADAS models and data

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The Atomic Data and Analysis Structure (ADAS) is an interconnected set of computer codes and data collections for modelling the radiating properties of ions and atoms in plasmas and for assisting in the analysis and interpretation of spectral measurements. Fundamental atomic data is mediated via collisional-radiative population models to produce the effective coefficients for practical use in impurity transport modelling, influx estimation, beam stopping efficiency and active charge exchange quantification. Away from the coronal picture, the simple connection between fundamental processes and the derived population or emissivity is lost. Instead these coefficients become dependent on many fundamental processes with unknown weightings.

The challenge is threefold: to develop methods for assigning an uncertainty to the fundamental data, to propagate these through the population models and to enable techniques to utilize within plasmas models atomic data that comes with an accompanying error surface.

Pure atomic properties, such as energy levels and some transition probabilities, are measurable and are known to high precision. However most of the fundamental data required for fusion work, such as excitation and state selective charge transfer cross sections, ionisation and recombination rates (for both electron and ion drivers) remain the result of theoretical calculations and this is not likely to change. The envelope of variation between different methods and calculations is the simplest approach to ascribing an error and is useful in identifying both the principal contributors to the final quantity of interest and to assess its domain of influence. A more refined approach, based on variation of the control parameters of the fundamental *ab initio* codes, is adopted for this smaller set of significant cross sections.

The error for the derived quantities is computed via a statistical sampling methodology assuming an error distribution within the ascribed uncertainty range of the fundamental inputs, thus generating a manifold of population solutions of which the half-width of the fit is taken as the error in the derived quantity.

Illustrative examples will be given to show how the uncertainty in fundamental data is manifested in the error in the widely used diagnostic charge exchange lines, in the equilibrium fractional abundance and radiated power of silicon and the shine through variation in a 2% carbon plasma. Applying errors in impurity transport codes is at an early stage and non-linear effects may prove to be important.

The ADAS database stores data in well defined ADAS Data Format (adf) files (of which there are approximately 50) and these data files are numerical tabulations over appropriate independent parameters such as energy, temperature or electron density. Enabling an error capability is a simple extension of storing an accompanying error file for each data file with the overall goal to have such matching error files for each dataset of the ADAS and OPEN-ADAS databases.