Atomic, Molecular And PMI Database In Current Edge Plasma Transport Codes, And Forward Sensitivity Analysis

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Magnetic fusion edge plasma transport codes resort to a large number of atomic, molecular and PMI data, in order to quantify these processes within the context of plasma dynamics in the outer and near target area of magnetic fusion devices. Many different edge plasma codes are in use, common to most of them is a 2D or 3D CFD treatment of the main plasma (electrons, ions) components, and a kinetic (often Monte Carlo) treatment of the neutral atomic, molecular components and some low concentration impurity ions. The B2-EIRENE family of codes is such an example. It constitutes amongst others the transport part of the SOLPS code suite, notably the SOLPS_ITER code hosted by ITER-IO.

These primary computational tools, which take A+M+PMI data as input, have to deal with the much more involved 'plasma state of matter' issues first. They are far less mature and limited in their predictive quality as compared to computational tools in other areas of sciences, e.g. to those taking nuclear data as input.

The data challenge (A+M+PMI data) in fusion edge plasma codes, and their uncertainty quantification, often comes in at a peripheral level. These codes isolate this A&M data sub-component of the model, computationally, and make them accessible for experimental quantification. If this separation is made, A+M data fall into the category 'known' parameters, plasma turbulence and flows, also PMI data, and all their consequences fall in the category 'unknown', uncertain, parameters.

In the present contribution we publicly expose the status of atomic, molecular and PMI data in fusion edge plasma codes, and we discuss their journey from the raw, unprocessed data towards condensed, properly averaged data used in integrated code models, as well as first attempts to quantify the uncertainty propagation during this data processing step. This latter is achieved by a (linear) forward sensitivity analysis option build into collision radiative codes for fusion plasma transport applications [1].

Pilot studies for propagation of the collision radiative A&M related uncertainties further, across the plasma flow simulations, governed by a system of partial differential equations (PDEs), onto the final quantities of interest, have meanwhile also been initiated. Efficient, adjoint-based sensitivity calculations establish the fundaments for this uncertainty propagation step. First results are discussed for a plasma flow model with a still simplified (fluid) treatment of the A&M aspects.

[1] See: http://www.hydkin.de/.