Issues with CR- and plasma chemistry modelling for fusion boundary plasmas

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Fusion boundary plasmas combine plasma physical challenges due to highly un-isotropic turbulent transport in electromagnetic fields with a rich plasma chemistry due to the presence of nearby material surfaces and plasma surface interactions. Quantifying the latter, to make the former experimentally accessible, requires accurate atomic and molecular and PSI data in a format and level of condensation (pre-processing) determined by the relevant spatial and temporal scales and proximity (or lack thereof) to equilibrium conditions.

Collisional radiative (CR) modelling provides processed atomic/molecular data after a separation of time-scales. The relevant types of derived CR data, such as electron cooling rates, radiation loss rates, etc. for fusion boundary plasmas, their similarities and differences with their astrophysical counterparts and common A&M data challenges data will be discussed, using the current H, H_2, and He CR databases i.e. data for the most abundant species in fusion boundary plasmas and divertors.

Data for chemical kinetics (equilibrium reaction rates), and the distinction from physical kinetics (often cross sections) in boundary plasmas are important for quantifying hydrocarbon transport and breakup in carbon surface based fusion devices (W7X, JT-60-super-upgrade) and for the Be-hydrides, Ammonia formation due to Nitrogen cooling, in metallic wall fusion machines. Only for the hydrocarbon system a full transition from chemical kinetic data to a physical kinetics database (cross sections) has been carried out, in the first decade of the present century, often in the framework of earlier RCPs of the agency. The status of the two latter (macroscopic) chemical kinetic databases as presently utilized in fusion studies, and their transformation into the more microscopic physical kinetics databases, will be discussed for the BeH_x and NH_x systems of molecules and their ions.

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