Impact of molecules on outer target plasma detachment in DIII-D using UEDGE*

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The impact of molecules on divertor plasma conditions in DIII-D ohmic plasmas have been investigated in simulations with the multi-fluid code UEDGE. The UEDGE predictions will be compared to coupled fluid-kinetic simulations and divertor measurements of target heat flux, radiated power and divertor plasma densities and temperatures. Previous studies have shown that molecular radiation plays a negligible role in the radiative power balance of the divertor plasma in ohmic conditions, while molecular processes can increase D_α line intensity by up to 50% for detached conditions [1]. The presence of molecules in divertor plasmas can also be used for assessing the electron temperature in ranges where recombination spectroscopy and probe measurements are inaccurate [2].

Presently, UEDGE treats molecules as a neutral, diffusive fluid species. A continuity equation is solved, considering recycling of molecules at the vessel walls and targets as the sole source, and a momentum equation to determine the molecular motion, where the molecular pressure is balanced by elastic scattering off atoms and ions. A user-defined, temporally constant, spatial temperature profile is used for evaluating the molecular temperature, which results in the molecular heat fluxes not being self-consistent. This contribution focuses on the implementation of a comprehensive molecular model into UEDGE, also solving an energy equation to self-consistently evaluate molecular target heat flux densities and incorporating a collisional-radiative fluid model of molecules, that describes molecular processes and radiation.

Ohmic discharges in DIII-D were simulated in UEDGE using the revised molecular model. These simple plasmas were chosen as subject of the investigation primarily due to the higher quality of the experimental data compared to other regimes. Additionally, the impact of molecules is assumed to be small for low density, high temperature plasmas, making them a natural starting point for evaluating a fluid molecular model before progressing to regimes where molecular effects are expected to play a more significant role. The UEDGE-predicted molecular density, temperature, and radiation will be validated against edge-fluid, neutral Monte-Carlo code EDGE2D-EIRENE simulations to elucidate differences of fluid versus kinetic neutral models. Additionally, the model predictions will be compared to Divertor Survey, Poor Resolution, Extended spectrometer [3] measurements of DIII-D molecular radiation to assess code-experiment agreement.

[1] M. Groth, et al., Nucl. Mat. and Energy (2018). Manuscript submitted for publication.
[2] U. Fantz, et al., Plasma Phys. and Contr. Fusion, **43** (2001) 907
[3] A.G McLean, et al., Nucl. Mat. and Energy (2018). Manuscript submitted for publication.

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