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Study of neutrals and impurity transport effects on divertor detachment

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A new self-consistent 1D scrape-off layer model is recently developed in BOUT++ framework, named SD1D [1][2], which includes equations of various particle species (e.g. main plasma, neutrals and impurities) and couples open databases like ADAS and AMJUEL [3]. It is able to fast and effectively simulate the divertor detachment experiments. The target electron temperature, the target ion saturation current and the variation of Dα radiation intensity in simulations are consistent with experimental results [4]. By using this model, a possible approach of divertor impurity control is studied. It is found that increasing upstream density intensifies the parallel transport, which pushes impurities (either intrinsic or extrinsic) towards the target. It may be helpful for control of the impurity radiation front (closer to the target).

In order to improving understanding of detachment on HL-3, SD1D is used to compare two detachment regimes (density ramp and impurity seeding) in HL-3 conditions. It is found that plasma-neutral interactions (for both deuterium atom and molecule) play a crucial role in the volumetric momentum and energy losses during density ramp detachment, while neutrals are less important during impurity seeding detachment since impurity seeding reduces the neutral recycling flux on the target and therefore mitigates plasma-neutral interactions. This work also finds that the roll-over of target current density is ascribed to a rollover of divertor ion source (decided by plasma-neutral interactions), which is only found in density ramp detachment but impurity seeding detachment on HL-3.

References
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