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P4.1015 Quantifying physical parameters in an outer divertor region using the Balmer line spectroscopy

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Mitigating head load on the divertor target is considered as one of the critical challenges to achieve a commercial fusion reactor. Fortunately, both density and temperature at the divertor target can be reduced significantly through a process called "detachment", leading to tolerable heat flux. However, our current understanding of the detachment process is mostly based on empirical laws and qualitative descriptions, and the extrapolation of the current detachment behavior to future reactors is not reliable.

The Balmer line spectroscopy is a non-intrusive diagnostic technique to characterize physical parameters in the cold divertor region. While this technique has successfully provided useful information at various devices[1, 2], the interpretation of the measurements is not straightforward due to line-integration effects. Modeling using the SOLPS code shows that spatial variations of the physical parameters need to be taken into account in the outer closed-divertor at ASDEX Upgrade(AUG). In the private flux where the density is high, both excitation and recombination emissions can possibly contribute to the total light intensity. On the other hand, in the scrapeoff-layer where the density is low, the recombination emission is typically negligible compared to the excitation emission. In order to interpret the Balmer line spectroscopy at AUG correctly, a "two-volume emission model" is developed. In this model, the emission along a line of sight is assumed to originate from two volumes to accommodate the spatial variations of the physical parameters. A Bayesian frame work is employed to determine the optimum values for the physical parameters based on the forward model. The two-volume emission model is applied to synthetic data and L-mode discharges with a density ramp. It is shown that this model robustly estimates important physical parameters, including the particle source and sink, in the outer divertor region.

References

[1] B.A. Lomanowski el al., Nucl. Fusion 55 123028 (2015) [2] K. Verhaegh et al., Nucl. Mater. Energy 12, 1112 (2017)

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