Interpretation of opacity measurements in the JET ITER-like wall divertor using a particle balance approach

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Recent improvements in spectroscopic measurements of the JET ITER-like wall divertor plasma temperature and density have facilitated estimates of the outer target volumetric ion source and sink rates using ADAS [1] inverse photon efficiency coefficients. In high-recycling outer divertor conditions a factor of three shortfall was found in the ionization rate obtained from Lyα intensity profiles compared to the reference Dα estimates. Additionally, radial profiles of the \(\frac{\text{Ly}β/Dα}{\text{AD}α/\text{Al}Lyβ}\) ratio suggest strong opacity of the Ly series lines at the outer target. To reconcile the Lyα ionization rate discrepancy, a detailed interpretation of opacity corrections using the population escape factor approach [2] is presented. To aid in the measurement interpretation and assessment of the impact of spectroscopy line-integration effects, an ad hoc opacity model is employed using the EDGE2D-EIRENE [3] fluid-neutral code package. Post-processing of the simulations with synthetic spectroscopy shows good correspondence to experiment which reinforces the estimated Lyβ and Lyα escape factor values at the outer target of less than 0.5 and 0.1, respectively, (i.e., more than 50% Lyβ and 90% Lyα photon reabsorption along the vertical line-of-sight). These findings suggest a renewed effort should be undertaken in the assessment of the opacity impact on both diagnostic interpretation and divertor plasma dynamics using the more sophisticated EIRENE photon transport model [4] in the context of metal wall tokamaks.

References

*See the author list of “Overview of the JET results in support to ITER” by X. Litaudon et al. 2017 Nucl. Fusion 57 102001.