Opacity measurements in the JET divertor

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Abstract

The combination of plasma density and path lengths encountered in divertor plasmas can lead to significant reabsorption of Lyman series radiation of the hydrogen fuel and its isotopes. It is crucial that the reabsorption or opacity of the divertor plasmas is understood, if they are to be reliably modelled in the next step machines such as ITER. Previous work on JET has included analyses by Lachin (1988) and Lomanowski *et al.* (2020). The present analysis relies on the observed near-constant ratios between the Lyman series line intensities and assumes that these ratios persist as the density changes. With this assumption a direct measurement of the absorption of the affected lines can be made and has been applied to JET pulses in which a density limit is achieved. Additional population due to molecular processes (Verhaegh *et al.,* 2021) will lead to an increase in the presently derived values of opacity.

As an example, in a H-fuelled L-mode density limit pulse, 91294, reabsorption is observed in the Lyman alpha, beta, gamma and delta lines with, respectively, opacities of 2.5, 1.5, 0.3 and 0.04 being reached along the VUV spectrometer's line-of-sight. Emission and absorption coefficients, together with the source functions are illustrated and populations of the ground and first four excited states determined. Differences in the ground state populations calculated using the different spectral lines are understood in terms of the reabsorption occurring at different points along the line-of-sight as well as the omission of population contributions from molecules in the present analysis.

Lachin T, 1988, UCL PhD Thesis, ISBN 9781339309101. Loarte A *et al.*, 2007, Nucl. Fusion, **47**, S203.
Lomanowski B *et al*., 2020, PPCF, **62,** 065006. Verhaegh K et al., 2021, PPCF, **63**, 035018.

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