# Inferring the role of plasma-atom and molecule interactions during divertor power exhaust

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Limiting the target power load to engineering tolerances on future reactors requires operating the divertor in a ‘detached’ state, during which plasma-atom and molecule interactions result in simultaneous power, particle and momentum losses. Obtaining quantitative information on these processes may facilitate detachment control and is necessary for studying the processes resulting in plasma detachment, driving improvements in divertor plasma models and divertor design.

Multiple atomic (**excitation** (of **H**), **electron-ion recombination** (of **$H^+$**)) and plasma-molecule interactions (involving **$H_2$**, **$H_2^+$** and **$H^-$**) result in excited atoms and line emission. The many processes involved complicates analyzing passive hydrogen spectra.

We present new spectroscopic analysis techniques for the hydrogen Balmer line series applied to TCV and MAST-U data where we trace the quantitative role of processes leading to hydrogen emission from which we estimate the contribution of plasma-atom and molecule interactions to power/particle balance [1]. An example of this analysis (TCV divertor) is shown in the color-coded Figure 1, indicating that many processes contribute to hydrogenic emission.

Our analysis shows plasma-molecule interactions can lead to a spatial displacement between the Lyman-β and Lyman-α divertor emission regions that has implications for the diagnosis of photon opacity when significant, as is expected for ITER & reactors. We will present techniques to account for opacity and this spatial displacement in our analysis.

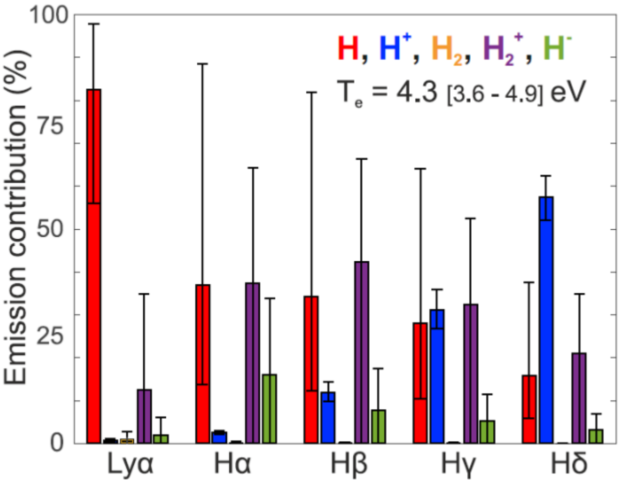


Figure 1: Hydrogen Lyman-α and Balmer line emission contributions from plasma-atom and molecule interaction

## References

[1] K Verhaegh et al 2021 Plas. Phys. Contr. Fus. [2] K Verhaegh et al 2021 Nucl. Mater. Energy