Contribution ID: **60** Type: **not specified**

An experimental analysis of the impact of plasma-molecule interactions on particle losses, atomic line emission and resulting power losses

Monday, 29 March 2021 15:00 (30 minutes)

Spectroscopic analysis techniques for the hydrogen Balmer series are presented [1] using Yacora-Online [2], where the quantitative role of processes leading to hydrogen emission are traced. These are used to estimate the contribution of both plasma-atom and molecule interactions to power/particle balance. Application of this to data from the divertor of the TCV tokamak results in a series of important observations [3]:
1. Plasma-molecule interactions result in excited atoms which significantly impact the hydrogen atomic line emission and the resulting radiative losses.
2. Plasma-molecule interactions, involving D_2^+ resulting in MAR, enhance the $D\alpha$ emission at the detachment onset.
3. Plasma-molecule interactions should be accounted for when low and medium-n hydrogen spectroscopy data ($n < 7$) is analysed.
4. The hydrogen emission enhancement from plasma-molecule interactions occurs near the target (where the molecular density is the highest) while the Fulcher band emission detaches off the target. That may have implications for using Fulcher band emission measurements for MAR estimates.

Detailed comparisons of the inferred particle balance as well as the measured and atomic extrapolation of $D\alpha$ against those obtained from SOLPS-ITER simulations [4] (which is vibrationally (D_2) unresolved) indicates that the impact of plasma-molecule interactions involving D_2^+ is underestimated. Agreement with SOLPS-ITER simulations is improved when the SOLPS-ITER simulations are post-processed using a $D_2 + D^+ \rightarrow D_2^+ + D$ rate specifically derived for deuterium [5].

This research has implications for analysing hydrogen spectroscopy measurements and the diagnosis of Molecular Activated Recombination (MAR). Its outcomes highlight the necessity of a more in-depth investigation on the importance of: 1) having isotope resolved rates for plasma-molecule interactions; 2) including vibrationally excited states individually in plasma-edge simulations.

References:
[1] K. Verhaegh, et al. 2021, Plasma Phys. Control. Fusion
[2] D. Wünderlich, et al. 2020, J. Quant. Spectrosc. Radiat. Transfer
[3] K. Verhaegh, et al. 2021, Nucl. Mater. Energy
[4] A. Fil, et al. 2017, Contrib. Plasma Phys.
[5] A. Kukushkin, et al. 2017, Nucl. Mater Energy

Primary author: Dr VERHAEGH, Kevin (Culham Centre for Fusion Energy, United Kingdom)

Co-authors: LIPSCHULTZ, Bruce (University of York); DUVAL, Basil (Ecole Polytechnique Fédérale de Lausanne – Swiss Plasma Center (SPC), Association Euratom-Confédération Suisse(EPFL) CH-1015 Lausanne, Switzerland); HARRISON, James (CCFE); Dr BOWMAN, Chris (University of York, York, United Kingdom); FANTZ, Ursel; FIL, Alexandre (Princeton University); Mr FEDERICI, Fabio (University of York, York, United Kingdom); FÉVRIER, Olivier (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland); MOULTON, David (CCFE); Mr MYATRA, Omkar (University of York, York, United Kingdom); Mr PEREK, Artur (Dutch Institute for Fundamental Energy Research, Eindhoven, the Netherlands); THEILER, Christian (EPFL-SPC); Dr WENSING, Mirko (École Polytechnique Fédérale de Lausanne); WÜNDERLICH, Dirk (Max-Planck-Institut für Plasmaphysik)

Presenter: Dr VERHAEGH, Kevin (Culham Centre for Fusion Energy, United Kingdom)

Session Classification: MOD/1 fusion devices