

MSc thesis

Experimental study on the isotopic exchange reactions between hydrogen isotopes and ammonia in the presence of metal surfaces

Gas seeding in fusion reactors is used to reduce the power loads on the tungsten divertor. For this purpose, nitrogen has been selected as seeding species because of its radiative properties and contribution to the plasma confinement. However, once ionised in the fusion plasma, the nitrogen ions and radicals will form stable compounds with the hydrogen isotopes, deuterium (D) and tritium (T). As a result, ammonia isotopologues (e.g., ND₂T) will be formed along the operation of the reactor. For the next fusion reactor ITER, the amount of tritium available for fuelling and the allowed inventory is limited and therefore it is of paramount importance to minimize the quantity of ammonia produced.

The metal surfaces in the fusion reactor (e.g., tungsten at the divertor) act as a catalyst for the production of NH₃, as demonstrated for instance by recent experiments carried out in our group^{1,2}. However, despite their relevance for a fusion reactor, the mechanisms of isotopic exchange between NH₃/D₂ and ND₃/H₂ in both gas and plasma phases, with and without metal surfaces, have not been studied. Therefore, experiments are required to investigate the production of hydrogen isotopologues at various conditions of isotopic ratios, catalyst temperatures, gas flows. This work will be carried out in our metal-free setup inside which different metal surfaces can be installed. This setup is equipped with a Residual Gas Analyser (RGA) for a real-time evaluation of the produced isotopologues. Before the start of the experimental campaign, a Python code used to deconvolute the contributions of similar mass-to-charge ratios species has to be adapted to the experimental conditions of interest to ensure the reliability of the measurements.

The work will be carried out in Prof. Ernst Meyer group with the direct supervision of Dr. Rodrigo Antunes. The experimental findings and scientific discussion in light of the results available in the literature concerning the kinetics of isotopic exchange reactions and plasma catalysis are meant to be compiled in an MSc thesis written in English.

¹M. B. Yaala, et al., Phys. Chem. Chem. Phys., 21 (2019) 16623²M. B. Yaala, et al., Nucl. Fusion, 60 :1 (2019) 016026