APPLICATION OF MACHINE-LEARNING TO SPECTROSCOPIC LINE EMISSION BY HYDROGEN ISOTOPES IN FUSION DEVICES FOR ISOTOPIC DETERMINATION AND PREDICTION

MOHAMMED KOUBITI

PIIM Laboratory, AIX-MARSEILLE UNIV, CNRS, Marseille, France
E-mail mohammed.koubiti@univ-amu.fr

Abstract. In magnetic fusion devices such as tokamaks and stellarators operated with a mixture of deuterium and tritium D-T, the knowledge of the isotopic ratio, i.e the ratio of the tritium density n_T to the total neutral density $(n_D + n_T)$ is crucial for both operational control and safety reasons. Because of safety reasons, the quantity of tritium in the vacuum vessel of ITER is limited to 700g according to Roth 2008. Therefore, any method allowing a real-time determination of such a parameter is strongly welcomed. Usually in H-D or D-D plasmas, the isotopic ratio $(n_D / n_H + n_D)$ is determined by fitting the experimental spectra of the Balmer-α line, i.e., Hα /Dα using an optimization algorithm based on a physical model. In this paper, I propose to apply Artificial Intelligence to Hα/Dα line spectra to identify the major spectral features, e.g., the positions and amplitudes of the peaks, the position of the dips and their y-values. These features with then be used by a Machine-Learning algorithm to determine the isotopic ratio in a faster way than a complete modelling or fitting of the entire profile of the line. By doing this, one can provide in real-time the values of the isotopic ratios along each spectral line of sight. The following step consists in the application of this method to the available spectroscopic data of several devices under H-D or D-D operation in order to extrapolate to D-T plasmas as expected for ITER in a later phase. We will make use here of a deep-learning tool (Tensorflow) based on neuronal networks. Some illustrations will also be shown using a supervised ML tool known as Sickit-Learn or SK-Learn see Pedregosa et al. 2011, this package was previously applied to the analysis of neutral helium ratios to determine the electron density and temperature in a linear simulator of a tokamak divertor, see Kajita et al 2021. Before tackling experimental data, I will consider synthetic spectra generated with given parameters using a python code, see Koubiti and Sheeba 2019. Finally, I will discuss the role that can be played by Artificial Intelligence in plasma physics.

References

Kajita, S. et al: 2021, *Plasma Phys. Control. Fusion*, **63**, 055018.
Koubiti, M., Sheeba, R.: 2019, *atoms* **7**, 23.
Roth, J. : 2008, *Plasma Phys Control. Fusion*, **50**, 103001.
Pedregosa, F. et al: 2011, *the Journal of machine learning research*, **12**, 2825.