3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

A review of spectroscopic techniques used for divertor plasmas of magnetic fusion devices

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In the domain of magnetic fusion, most Tokamaks are equipped with divertors which allow to separate the plasma-material interaction zone from the confined plasma, hence reducing considerably the contamination of the latter by impurities. Divertors, where open magnetic field lines hit some targets of the plasma-facing materials, have a crucial role consisting in supporting huge heat and particle loads escaping from the confined plasma core. However, the optimal scenario for such devices is the detachment regime corresponding to a high density low temperature divertor plasma reached when volume recombination becomes dominant in comparison of ionization. This regime is of a great importance for the issue of power exhaust as can be understood from [1-2]. It is therefore easy to understand why it is important to characterize divertor plasmas and for that plasma spectroscopy plays has a key role [3]. In this paper, a review will be given, as complete as possible of the various spectroscopic techniques and methods used to characterize the divertor regions of Tokamaks but also other devices like stellerators. It covers both passive and active spectroscopic techniques will be illustrated through examples. Each technique will be considered from both the theoretical and experimental points of view. When possible, examples from the latest experiments realized on European tokamaks will be presented. In this paper, a large part will be devoted to the topics of Stark broadening and Zeeman effect for hydrogen emitters [4] but also for impurity emitters. Each method or technique will be carefully analyzed through the criteria of its validity, its limitation and the way it can be improved.

References

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