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Spectroscopic models for the diagnostic of laboratory and astrophysical plasmas

J. Rosato[1], M. Meireni[1], R. R. Sheeba[1], M. Koubiti[1], Y. Marandet[1], R. Stamm[1], N. Bonifaci[2], Z. Li[3], J. Eloranta[4]

[1]PIIM, UMR 7345 Aix-Marseille Université / CNRS, Centre de St-Jérôme, 13397 Marseille Cedex 20

[2]G2ELab, CNRS and Grenoble University, 25 rue des Martyrs, 38042 Grenoble

[3]Guizhou Institute of Technology, Caiguan Road 1, Guiyang 550003

[4]Department of Chemistry and Biochemistry, California State Unviersity at Northridge, 18111 Nordhoff St., Northridge, CA 91330

e-mail: joel.rosato@univ-amu.fr

We give a review on the modeling tools employed in plasma optical emission spectroscopy for diagnostic purposes. A focus is put on the broadening of atomic lines due to the plasma microfield (Stark effect) and due to collisions with neutrals. These two mechanisms are related to the density of particles, so that an analysis of experimental spectra using an appropriate model provides information on this parameter. We give an overview of models and calculation techniques and we illustrate them through applications to a set of selected spectra observed in laboratory and astrophysical plasmas. The formalism involved therein employs the atomic dipole autocorrelation function as a fundamental quantity of interest [1]. This quantity is calculated as a statistical average over a set of configurations accessible to the system formed by an atomic emitter immersed in a plasma. The spectrum is next obtained by performing a Fourier transform. Three issues are examined in this work: (i) the modeling of ion dynamics effects, which provide an additional line broadening; (ii) the description of electron broadening through a collision operator; (iii) the description of collisions with atoms, which occur in particular in partially ionized plasmas. These issues will be illustrated through recent analyses done in the framework of magnetic fusion research [2], electrical engineering [3,4], and stellar atmosphere investigations [5].

References

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