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Progress Report

SIMULATION CALCULATIONS OF HYDROGEN LINES SUBMITTED TO OSCILLATING ELECTRIC FIELDS

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The effect of oscillating electric field on spectral line shapes has a long history in plasma spectroscopy [1]. Such fields may be generated by an external source, such as a microwave generator or laser radiation, with the aim of diagnosing or heating the plasma. Oscillating electric fields may also be created in the plasma, since the long range of electric and magnetic fields in a plasma favor collective phenomena such as the development of fluctuations and oscillations. A frequently observed phenomenon is the excitation of a wave, which after amplification by an instability will rise above thermal fluctuations and become a propagating wave able to transport energy and information. As an example, Langmuir waves are ubiquitous in many types of laboratory, fusion, and astrophysical plasmas. Their effect on a spectral line shape has been studied since several decades by using approaches based on kinetic theory and retaining the quantum effects of the emitting particle [1]. For all these situations the effects predicted depend on the plasma conditions, and on the ratio W of the wave energy density to the thermal energy density $W = \varepsilon_0 E_L^2/4N_e k_B T$, with T and N_e the hydrogen plasma temperature and density, E_L the magnitude of the wave, k_B the Boltzmann constant, and ε_0 the permittivity of free space. Depending on such plasma parameters, the existing models predict modifications on the line shape, with changes in the widths or the appearance of satellites [1]. Starting with a plane wave having a random phase, we revisit the role of such waves on hydrogen lines by using a computer simulation [2,3] for averaging the emitter dipole autocorrelation function (DAF) over a set of initial phases and values of the oscillating electric field. We look particularly at how these parameters affect the response of the DAF and line shape at the oscillating frequency and its harmonics. By increasing the ratio W, we can explore the transition region from linear to nonlinear effect of single Langmuir waves. In particular, for conditions with W of the order of one or larger, the Langmuir waves couple with ion sound and electromagnetic waves, with the plane wave model being no longer valid, and one enters the wave collapse regime which requires a specific modeling [2,4]. We will present hydrogen Lyman and Balmer DAF and line shape calculations for plasma conditions found in laboratory plasmas, edge fusion plasmas and stellar envelopes.

References

[1] Lisitsa, V.: 1994, Atoms in plasmas, Springer, Berlin.
[2] Hannachi, I., Stamm, R., Rosato, J., Marandet, Y.: 2016, *EPL*, **114**, 2300.
[3] Hannachi, I., Meireni, M., Génésio, P., Rosato, J., Stamm, R., Marandet, Y.: 2017, *Atoms*, **5**,34.
[4] Hannachi, I., Meireni, M., Rosato, J., Stamm, R., Marandet, Y.: 2018, *Contrib. Plasma Phys.*, **58**, 583.