Hindawi Publishing Corporation
International Journal of Spectroscopy
Volume 2010, Article ID 478539, 2 pages
doi:10.1155/2010/478539

Editorial

Spectral Line Shapes in Plasmas and Gases

Eugene Oks,[1] Elisabeth Dalimier,[2] Roland Stamm,[3] Chantal Stehlé,[4] and Manuel A. Gonzalez[5]

[1] *206 Allison Laboratory, Department of Physics, Auburn University, Auburn, AL 36849, USA*
[2] *Université Pierre et Marie Curie, Laboratoire LULI-UMR 7605, Université Paris 6, Case 128, 4 Place Jussieu, 75252 Paris Cedex 05, France*
[3] *Universite de Provence, Physique des Interactions Ioniques et Moleculaires, Centre de Saint Jerome, case 232, 13397 Marseille Cedex 20, France*
[4] *Laboratoire d'Etudes du Rayonnement et de la Matière en Astrophysique, UMR 8112 du CNRS, Observatoire de Paris, Université Pierre et Marie Curie, 5 Place J. Janssen, 92195 Meudon, France*
[5] *Departamento de Fisica Aplicada, E.T.S.I. Informatica, Universidad de Valladolid, 47071 Valladolid, Spain*

Correspondence should be addressed to Eugene Oks, goks@physics.auburn.edu

Received 27 October 2009; Accepted 27 October 2009

The subject of spectral line shapes (SLS), a.k.a. spectral line broadening, which embraces both shapes and shifts of spectral lines, is of both fundamental and practical importance. On the fundamental side, the study of the spectral line profiles reveals the underlying atomic and molecular interactions. On the practical side, the spectral line profiles are employed as powerful diagnostic tools for various media, such as neutral gases, technological gas discharges, magnetically confined plasmas for fusion, laser- and Z-pinch-produced plasmas (for fusion and other purposes), astrophysical plasmas (most importantly, solar plasmas), and planetary atmospheres.

The research area covered by this special issue includes both the SLS dominated by various electric fields (including *electron and ion microfields* in strongly ionized plasmas) and the SLS controlled by *neutral* particles. In the physical slang, the former is called "*plasma broadening*" while the latter is called "*neutral broadening*" (of course, the results of neutral broadening apply also to the spectral line broadening in neutral gases).

The goal of this special issue is to demonstrate the most recent developments in this field. Topics presented here are basically the same as for the biannual International Conference on Spectral Line Shapes. This special issue contains 4 review articles and 11 original research papers.

The first paper is a review article discussing the role of the fully numerical simulations and complicated codes, which are important as the third powerful research methodology, with respect to experiments and theories. It shows by examples the pitfalls of the trend where the ultimate test of any theory is considered to be fully numerical simulations and complicated codes instead of experiments conducted in well-controlled conditions.

The second paper is a review article discussing the spectral profiles of the quasimolecules formed in hot and dense plasmas as two nuclei share a bound electron. The study of spectral profiles is shown to be strongly related to the collision dynamics of ions in excited states.

The third paper is a review article devoted to the current status of the concept of plasma microfield. In this review, the physical aspects of the most employed models are analyzed and some open questions are highlighted.

The fourth paper is a review article presenting a quantum statistical approach for calculating the line shape of neutral helium lines in dense plasmas. The shifts and widths of several lines are calculated and compared to experimental results and other models.

The fifth paper revisits time ordering effects in Stark profiles using simulation techniques that permit to reproduce the motion of the heavy particles in the plasma and to obtain the electric fields at the location of the emitter. By considering jointly Zeeman and Stark effects, the authors obtained valuable spectral line profiles to be used in fusion plasma diagnostics.

The sixth paper provides a coherent description of the hydrogen Brackett line shapes for plasma conditions relevant to stellar observations in the corresponding infrared range. It supplies tables of line profiles for astrophysical applications intended to gain an insight into the physical properties of stars.

The seventh paper employs a new statistical multiparticle approach to calculate the effect on spectral line caused by the acceleration of the perturbing electrons by the ion field. It shows that two totally different analytical approaches (dynamical and statistical) agree with each other by leading to the reduction of the electron Stark broadening and, therefore, disprove the corresponding recent fully numerical simulations that claimed an increase of the electron Stark broadening.

The eighth paper proposes a modelling of the distribution of collision times, and a study of their effect on collision-induced molecular spectra. The use of a Poisson distribution of velocities is shown to lead to an exactly soluble and realistic model.

The ninth paper reports experiments performed using laser-induced breakdown spectroscopy for studying the evolution of C_2 and C_3 formation. This technique also allowed the authors to study the carbon migration in the plasma cell.

The tenth paper presents a unified impact model for neutral species—the model incorporating velocity changing effects and the speed dependence of coherence destruction. Simple closed expressions are obtained for the dipole correlation function, retaining the cubic time term.

The eleventh paper presents a quantum theoretical study of the depolarized Raman spectrum of compressed hydrogen gas at low temperature with a detailed analysis of the various contributions to the line shape, as well as a comparison with the experiment at the temperature of 50 K. These calculations show the important contribution of interference and shape resonance effects.

The twelfth paper reports the measurements and analysis of Stark-broadened profiles of the H-gamma line emitted from plasma formed by laser-induced optical breakdown in a pulsed methane flow. The obtained values of the electron density are in a good agreement with the corresponding values found previously from Stark-broadened profiles of the H-alpha and H-beta lines.

The thirteenth paper presents new results on the energy and dipole surfaces of the complex H_2–H_2, allowing for the calculation of the corrsponding rototranslational absorption spectra. These spectra are of great interest for astrophysical applications as they extend the available data to higher temperatures, up to 2000 K.

The fourteenth paper explains how the spectrum of Flucher alpha diagonal band of hydrogen molecules can be prudently chosen to diagnose the temperature of hydrogen-containing high-frequency electrodeless lamps. These lamps are used for a wide range of applications.

The fifteenth paper is an experimental measure of absorption line of atomic hydrogen by diode laser spectroscopy. The fitting of the spectra by two Gaussians reveals the existence of low and high temperature components, thus allowing their ratio to be used for monitoring the dissociation of molecular oxygen.

Eugene Oks
Elisabeth Dalimier
Roland Stamm
Chantal Stehlé
Manuel A. Gonzalez