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Stark profile measurements using degenerate four-wave mixing (DFWM) laser spectroscopy and laser Thomson scattering

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The critical review of the experimental data on Stark broadenings, recently published by Konjevic *et al.* [1], indicates that the experimental techniques have not advanced considerably over the last decade to result in the data of better accuracy. This situation limits progress in the field of astrophysics, laboratory plasma research and its applications, and also in line profiles calculations.
In fact, the experimental results are almost exclusively based on optical emission spectroscopy (OES). A simple experimental setup and non-intrusive measurement are its major advantage. On the other hand, only intensity integrated along a line of sight can be directly measured. So determination of local plasma parameters is often difficult or even impossible. Moreover, the spectral accuracy of the OES method is greatly reduced due to influence of the Doppler effect on the measured line profiles.
Therefore we have made an effort to apply nonlinear laser spectroscopy to the measurements of Stark profiles. Degenerate four-wave mixing (DFWM), the method referred to, is a method of high spatial resolution thus ideal for local studies of plasma. The DFWM in configuration with two counter propagating laser beams (backward phase-conjugate geometry) gives spectral profiles with significantly reduced Doppler broadening.

The separate problem in studies of Stark profiles is plasma diagnostic. Electron concentration and temperature are determined using Stark profiles (mainly H_α and H_β of hydrogen), the total intensity of spectral lines or the intensity of plasma radiation background. The precision of many diagnostics techniques also depends on accuracy of the electron transition probabilities for the investigated spectral lines when, for instance, the Boltzmann-Saha plot is constructed.
The method we use for measurements of plasma parameters is laser Thomson scattering (LTS) method. Its main advantages are good spatial resolution and relatively simple relation between the characteristic of the measured spectrum and electron density and temperature. Furthermore, the final result is independent on the plasma state.
The high experimental accuracy in our measurements of Stark profiles, is achieved by simultaneous measurements of DFWM profiles and LTS spectra using a spectrograph and a gated ICCD camera. However, due to the small cross sections for some of the laser scattering processes the experiments require high power pulsed laser which can result in strong plasma disturbance. It follows that the results need careful approach and often simple linear extrapolation of final results to the laser pulse energies can give misinterpretation of physical phenomena.

[1] N.Konjevic, A.Lesage, J.R.Fuhr and W.L.Wieses, J.Phys.Chem.Ref.Data **31**, 819 (2002)