Study of Stark broadened hydrogen line profiles using laser-induced plasma, laser Thomson scattering and *ab initio* computer simulations

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The analysis of the Stark broadened line profiles emitted by hydrogen atoms is the basic method of plasma diagnostics. This is due to the strong sensitivity of their widths to the charged particle concentration in plasma. However, it turns out that much more information about plasma can be inferred by examining **full profiles of hydrogen lines**, as shapes of practically all of them also depend upon the kinetics of the emitter-perturber system, the so-called **ion dynamics effect**. Despite the fact that such profiles have been the subject of many theoretical models for several decades, their results have never been unambiguously confirmed experimentally.

This work concerns detailed investigations of the profiles of the Balmer hydrogen spectral lines in the laser-induced plasma. The measured emission profiles, together with independently determined plasma parameters - electron concentration, their temperature and the temperature of perturbing atoms and ions - are used to verify the calculations performed by the *ab initio* computer simulations [1].

In our studies the laser-induced plasma (LIP) is generated as a result of the laser breakdown in pure hydrogen gas under reduced pressure. High precision plasma diagnostics is achieved using the laser Thomson scattering (TS), with a second harmonic of a Nd:YAG laser as the probe beam, as described in [2]. TS is characterized by high spatial and temporal resolution and most importantly the scattering spectra are directly related to the plasma parameters. Therefore they are independent of the accepted and at the same time difficult to verify hypotheses about the equilibrium state of the plasma.

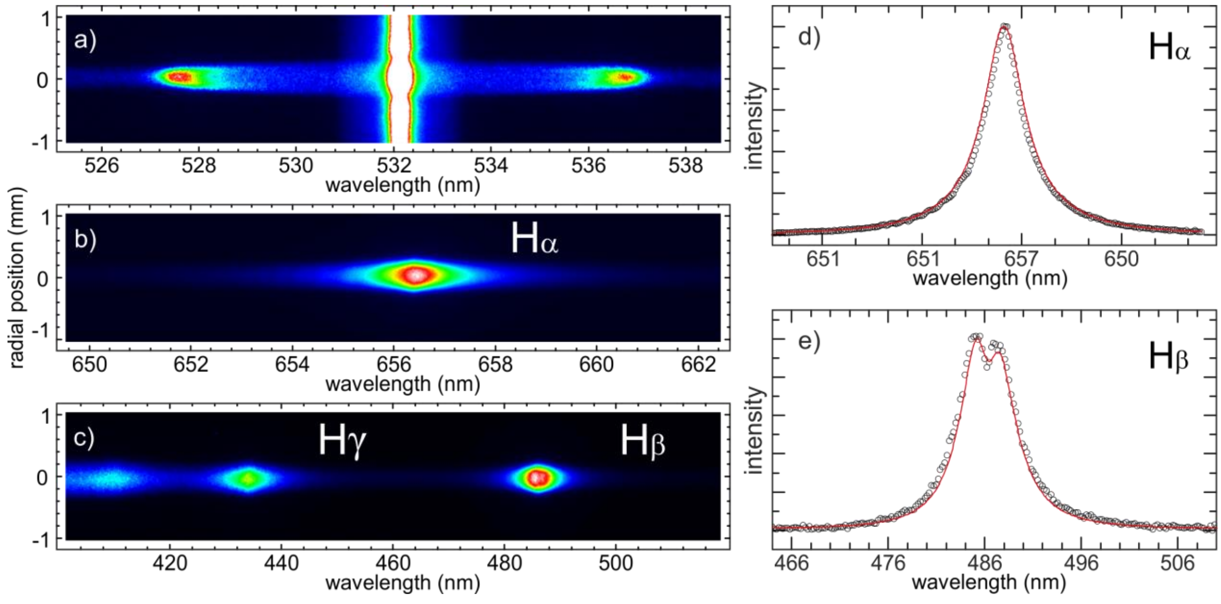

Fig. 1: The spectrum of the Nd:YAG 532 nm laser beam Thomson scattering on LIP generated by the laser breakdown in hydrogen gas (a), the spectrum of the H_α emission line (b), the spectrum of the H_β and H_γ emission lines (c), the measured profile of the H_α line (black circles) and the simulated profile of that line convoluted with the apparatus profile (red line) (d), the measured profile of the H_β line (black circles) and the simulated profile of that line convoluted with the apparatus profile (red line) (e).

References

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