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Laser induced fluorescence determination of electric fields in R.F. discharges

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A knowledge of the temporal and spatial variations of the electric field in radio-frequency gas discharges is essential for rigorous testing of the numerous self-consistent models that have been recently proposed for the charged particle behaviour. We have developed a new method for the non-perturbative in-situ determination of electric fields, based on laser induced fluorescence of Rydberg state H atoms present in H₂-containing discharges. The atoms are excited to the n=2 state by two photons at 243nm, then further excited to n=6 by one photon at 410nm, with detection of the H α emission, produced by radiative and collisional cascading. A system comprising two dye lasers pumped in parallel by a single XeCl excimer laser is used to accomplish this. Analysis of the Stark splitting of the n=6 state, observed from the structure of the 2-6 excitation profile, allows the electric field to be determined. Results are presented for 30kHz, 1Torr H₂ discharges, with temporal (30ns) and spatial (0.5mm) resolution and detection of fields as low as 20V/cm. As well as the previously observed temporal asymmetry of the cathode sheath¹, we have measured fields of up to 70V/cm close to the electrode in the anodic half-cycle.

¹J.P.Booth, J.Derouard, M.Fadlallah, and N.Sadeghi, J.Appl.Phys. **74**, 862, (1993)