Laser Spectroscopy on Low-Temperature Plasmas: Where are we going?

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The history of the LAPD meeting has always mirrored well the evolvement of laser spectroscopy in plasma physics. Particularly, in the field of low-temperature plasmas, an amazing number of techniques has been developed over the past decades. However, the development of new laser spectroscopic techniques cannot be separated from the trends and the related needs in the field. Over the past decade, a strong shift of topic from low-pressure plasmas to atmospheric pressure plasmas can be observed. These plasmas are very small (typically 0.1 to 1 mm size) and often transient on a ns-scale. Further, collisionality of electrons with neutrals is in the THz range and often population transfer between excited states atoms and molecules plays a significant role. On the other hand, population densities are notably higher than in low-pressure discharges and naturally, the high collisionality leads to strong electric fields even in the quasi-neutral bulk of the plasma. Due to the small size, limited access and the highly transient time scale, optical techniques are often the only diagnostics applicable (plus current and voltage measurements and possibly mass spectroscopy in the effluent). The particular plasma features at high pressures have enabled some new spectroscopic techniques, like e.g. ps-resolved electric field induced second harmonic generation (EFISH) for electric field measurements, frequency-comb spectroscopy on molecules, or a re-vitalization of coherent anti-Stokes Raman spectroscopy (CARS). For the later, exciting developments show enhanced performance on the fs time-scale. The talk will give an overview of some of the most recent techniques and will provide also a personal perspective of possible near future developments.

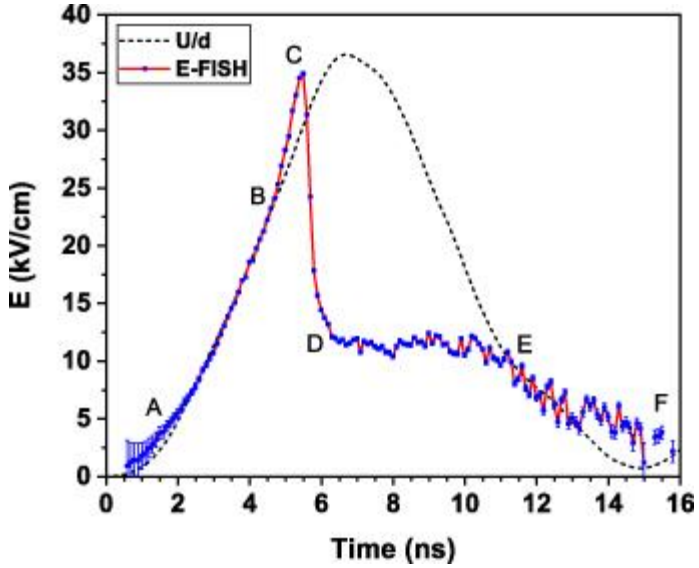

Figure 1. Example of a 100 ps time resolved electric field measurement in a ns-pulsed, near-atmospheric pressure micro-discharge in nitrogen/helium by EFISH [1].

[1] N. D. Lepikhin et al., 2021, J. Phys. D: Appl. Phys. 54, 055201.

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