Pretty exciting - Calibrated OH laser-induced fluorescence spectroscopy, opportunities and challenges in unravelling the role of H_2O in CO_2 plasma conversion

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Introduction

The consideration of water in the plasma conversion of carbon dioxide is crucial due to its role as omnipresent impurity and/or abundant hydrogen source [1]. Quantitative in situ measurements by laser-induced fluorescence (LIF) spectroscopy facilitate our understanding since OH radicals serve here not only as reactant but also as probe of the CO_2 conversion [2, 3]. A CO_2-H_2O glow discharge serves as non-equilibrium environment. Quantitative measurements are impeded by spectral overlap of OH with excited CO [4].

Setup

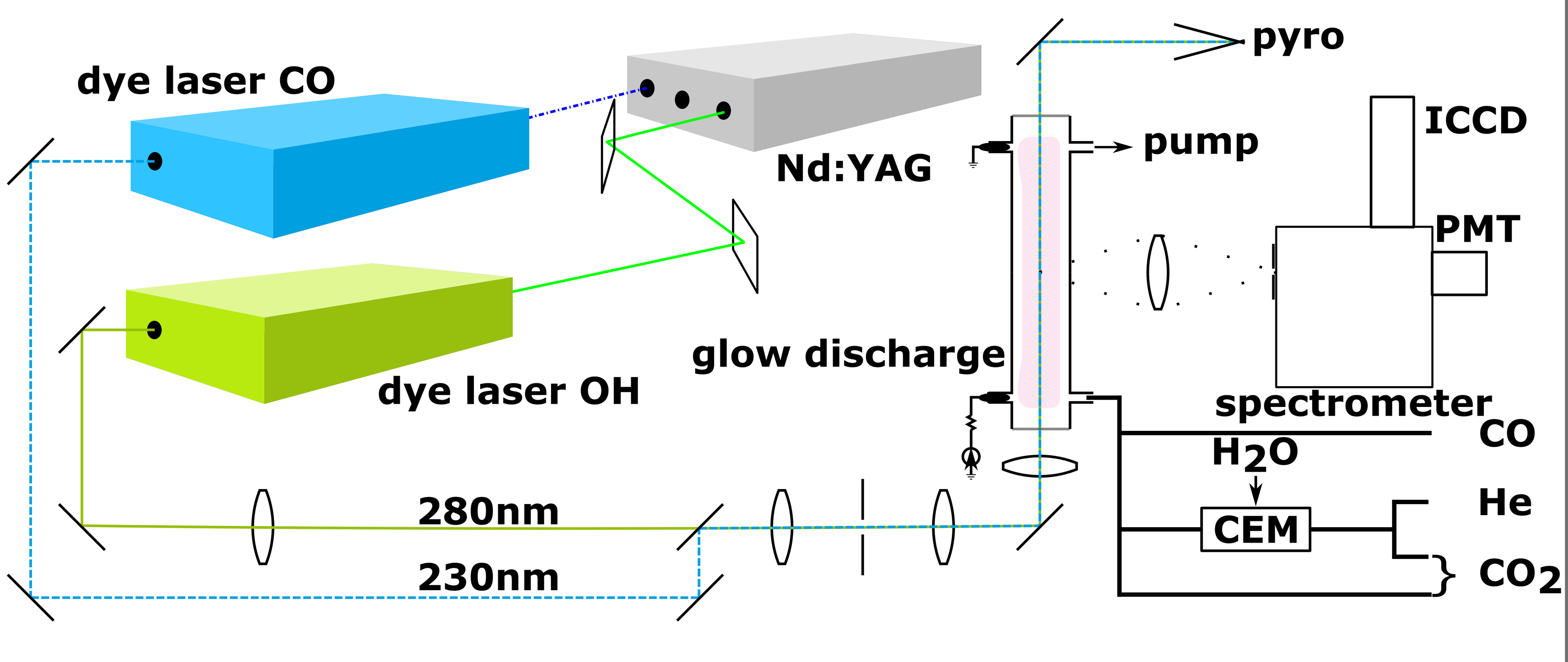

Fig. 1: Used setup for absolute OH LIF measurements in a CO_2-H_2O glow discharge at 6.67mbar. Calibration by CO TALIF.

Spectral Overlap with CO

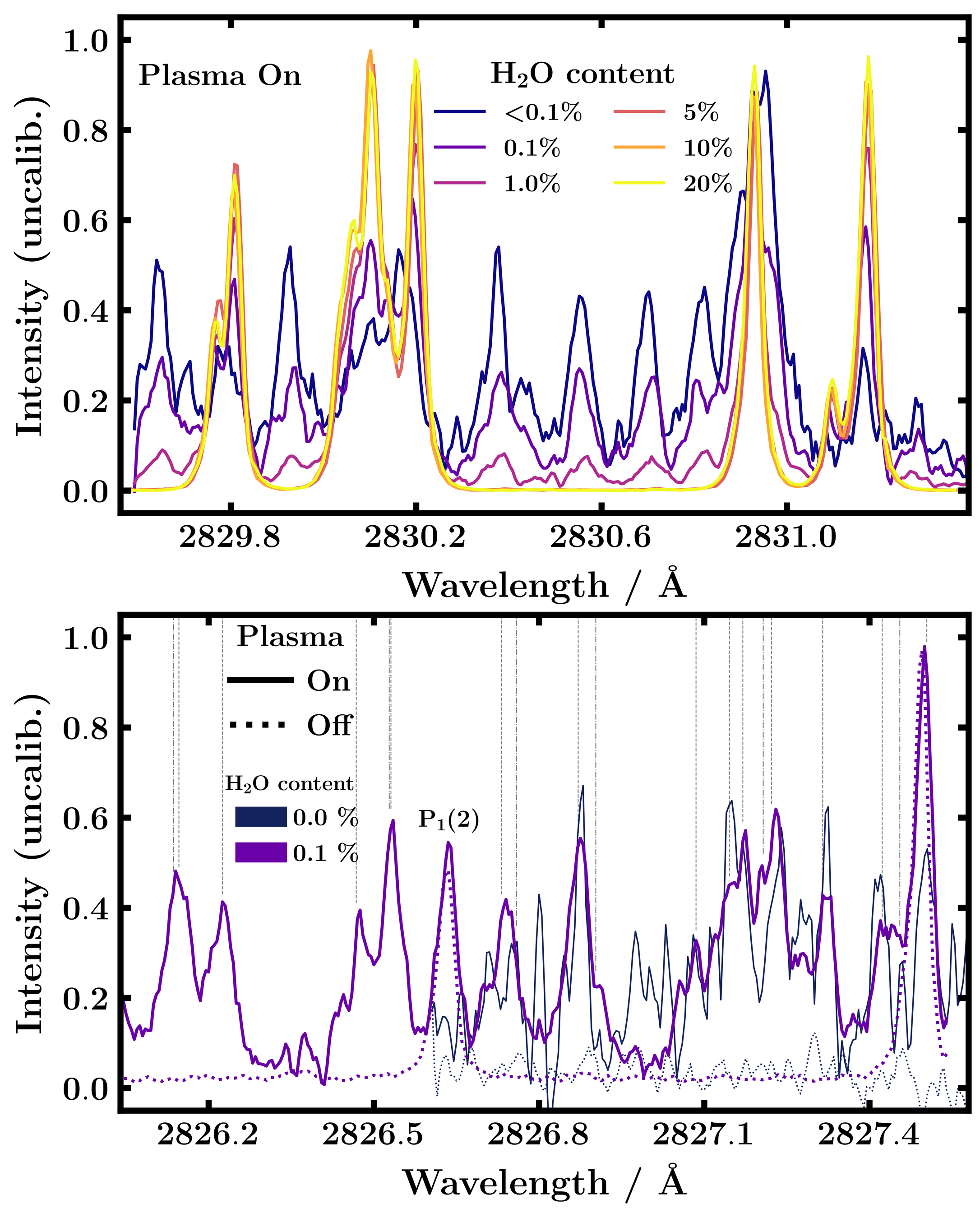

Fig. 3: Distortion of the OH excitation spectrum for decreasing water admixture, due to spectral overlap with the third positive system of CO (top) and proposition of the overlap-free $P_1(2)$ for quantitative measurements (bottom) [5, 6].

Quantitative LIF in a Glow Discharge

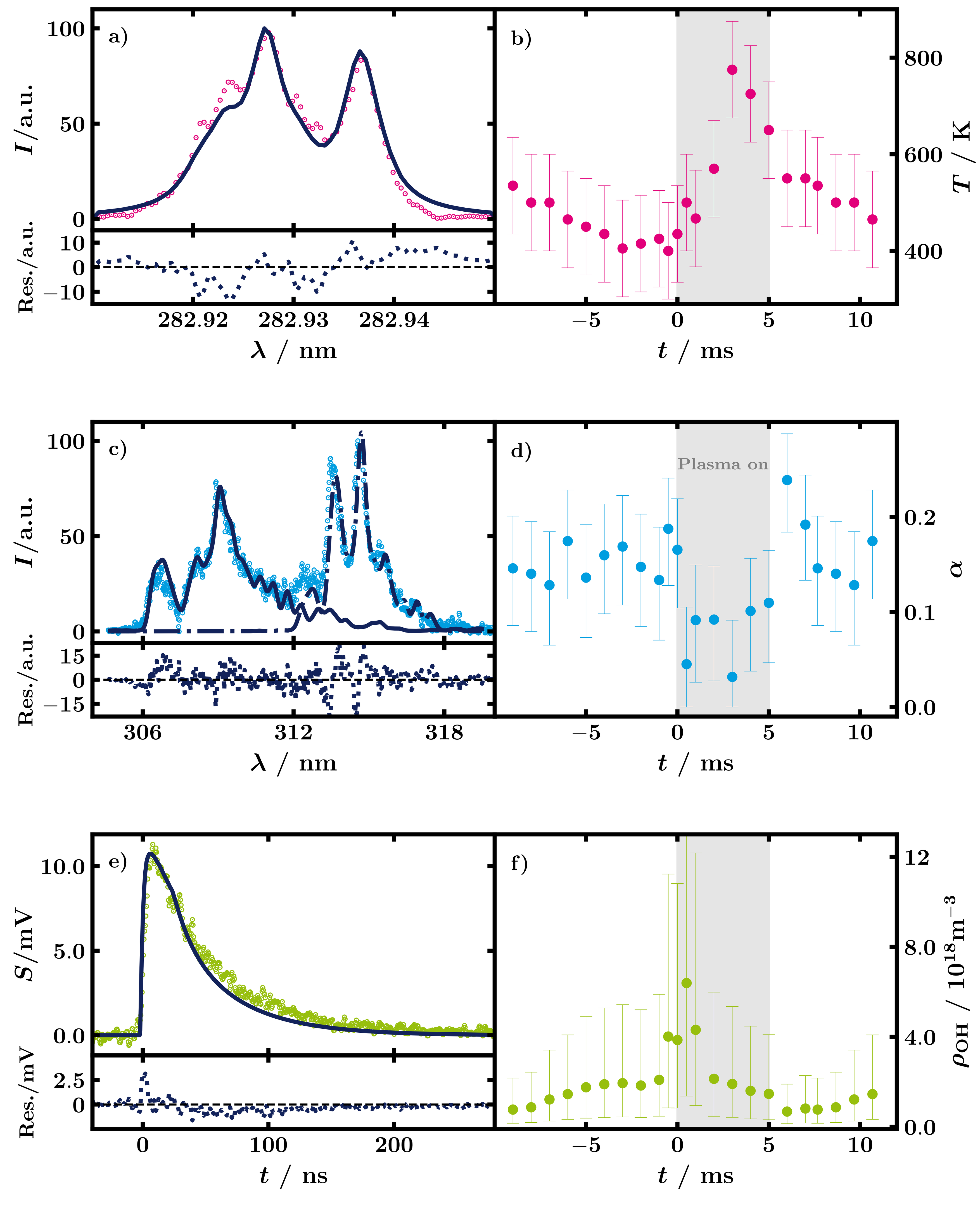

Fig. 2: Simulation of experimental observables like excitation spectrum (a), fluorescence spectrum (c) and fluorescence pulse (e) to obtain the time-dependent rot. temperature T (b), CO_2 conversion α (d) and OH density ρ_{OH} (f) with respect to the plasma.

Literature

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Conclusion

- Suggestion of new OH LIF calibration method by CO TALIF
- Measurement of absolute OH number density in pulsed DC CO_2-H_2O glow discharge for the first time
- Confirmation of conversion drop in plasma on-time
- Proposition of excitation of $P_1(2)$ of OH to avoid spectral crosstalk with the third positive system of CO
- Demonstration of single-photon CO LIF

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