CELIF: Cavity-Enhanced Lase-Induced Fluorescence

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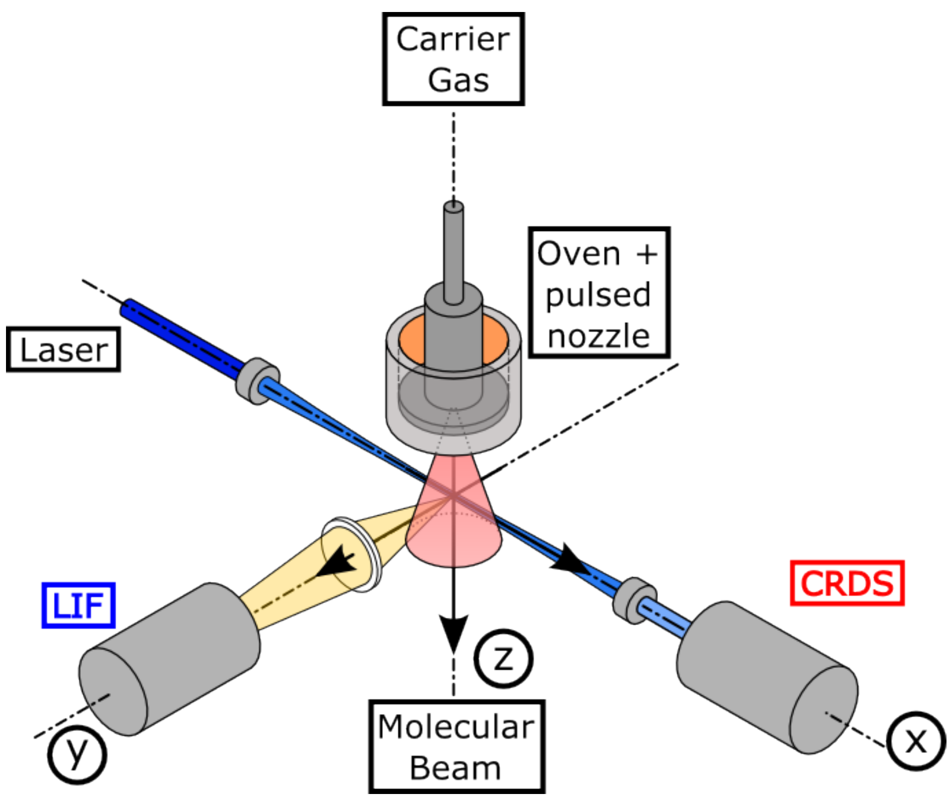
We describe a novel experimental setup that combines the advantages of both laser-induced fluorescence and cavity ring-down techniques. We perform a simultaneous and correlated ring-down and fluorescence measurement of the same sample in a single, pulsed laser beam. The combined measurement provides the calibration to extract absolute absorption coefficients from the fluorescence measurement which extends the dynamic range of a stand-alone cavity ring-down setup from typically three to at least six orders of magnitude. The presence of the cavity improves the quality of the signal, in particular the signal-to-noise ratio. The methodology, dubbed cavity-enhanced laser-induced fluorescence (CELIF), is developed and rigorously tested against the spectroscopy of 1,4-bis(phenylethynyl)benzene in a molecular beam and density measurements in a cell. We outline how the method can be utilised to determine absolute quantities: absorption cross sections, sample densities and fluorescence quantum yields.[1] In a further study, the absolute density of SD radicals in a supersonic jet has been measured down to $(1.1 \pm 0.1)\text{x}10^5$ cm^{-3}. Such a density corresponds to 215 ± 21 molecules in the probe volume at any given time. The minimum detectable absorption coefficient was quantum noise-limited and measured to be $(7.9 \pm 0.6)\text{x}10^{-11}$ cm^{-1}, in 200 s of acquisition time, corresponding to a noise- equivalent absorption sensitivity for the apparatus of $(1.6\pm0.1)\text{x}10^{-9}$ cm^{-1} $Hz^{-1/2}$.[2]



References
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[2] A. Mizouri, L. Deng, J. S. Eardley, N. H. Nahler, E. Wrede, D Carty, Phys. Chem. Chem. Phys. 2013, 15, 19575. DOI: 10.1039/C3CP53394H