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New spectroscopic techniques with and based on optical frequency combs

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Optical frequency combs since their development brought promise for broadband, sensitive spectroscopic measurement especially with the combination with optical cavities. The superb frequency precision and accuracy would be combined with high sensitivity brought by elongated interaction time of light with the intra-cavity molecular sample.

Recent developments in this field, including the tight locking between the laser light and cavity modes and high level of control of their relative frequencies (at Hz and sub-Hz levels) resulted in a whole set of new experimental approaches to cavity-enhanced spectroscopy.

As the width and frequency of the cavity mode depends on the intracavity medium, one can simultaneously determine the absorption and dispersion of the molecular sample, in the latter relying only on the frequency measurements. Such measurements can be accurately performed with continuous-wave lasers (cw-lasers)[1] as well as optical frequency combs[2,3,4]. The time-dependent interference between the transient cavity field oscillating at the mode frequency and that of a local oscillator which is precisely detuned from this resonance, enables the determination of the absorption coefficient at short timescales (faster than cavity ring-down time), this approach was presented as cavity buildup dispersion spectroscopy (CBDS) technique[5]. Finally, already considered golden standard in gas metrology cavity ring-down technique (CRDS) has been demonstrated in broadband manner both with dual-comb spectrometer (DC-CRDS)[6] as well as with mechanical Michelson interferometer (FT-CRDS)[7].

Thanks to the non-linear conversion those techniques are applicable in the wide range of frequencies, reaching also to fingerprint, mid-infrared region and lower frequencies.

In the talk the main ideas behind those approaches will be presented, illustrated with the results of experiments, including dual-comb and FTS-based CRDS, cavity mode-width spectroscopy with cw-laser and comb-based broadband approach as well as accurate molecular line position measurements in the mid-infrared range.

[1] A. Cygan *et al.*, *Opt. Express* **23**, 14472 (2015).
[2] L. Rutkowski *et al. Optics Express* **25**, 21711 (2017).
[3] G. Kowzan *et al. Sci. Rep.* **9**, 8206 (2019).
[4] D. Charczun *et al. Measurement* **188**, 110519 (2022).
[5] A. Cygan *et al.*, *Commun. Phys.* **4**, 14 (2021).
[6] D. Lisak *et al.*, *Sci. Rep.* **12**, 2377 (2022).
[7] R. Dubroeucq, L. Rutkowski, *arXiv:2201.11725* (2022).