A WALK THROUGH THE WORLD OF CAVITY ENHANCED LASER SPECTROSCOPY: IN THE LAND OF OPTICAL FEEDBACK

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Cavity enhanced laser absorption spectroscopy is based on the use of a resonant optical cavity as the sample cell to provide long optical absorption path length. Photons trapped between the highly reflective mirrors (R>99.99%) of the optical cavity will have a very long lifetime in the absence of intracavity absorption, which translates into an effective absorption path length that can easily reach tens of km, while the set-up is very compact (1 m).

More specifically, our group has developed an original technique called "Optical Feedback - Cavity enhanced Absorption Spectroscopy" which solves one of the most pertinent problems of other long path-length spectroscopic technique implementations (such as Cavity Ring-Down Spectroscopy - CRDS) : the difficulty of injecting a sufficient amount of laser light into a very high finesse optical cavity. By taking advantage of a specific "optical feedback" (OF) induced by the optical cavity, the laser line width emission is strongly reduced and the cavity transmission increased to a level that is orders of magnitude larger than in competing techniques. OF-CEAS, enables the design of a compact and robust instrument with very high detection sensitivity (5 10^{-10} cm^{-1}) and very high molecule specificity, with a small gas sampling volume (20 cm^3). Importantly, OF-CEAS provides quantitative absorption measurements in real-time (10 Hz) without the need for periodic calibration with certified gas mixtures.

OF-CEAS analysers are therefore ideally suited to quantitative in-situ measurement of a specific molecular species at very low concentration in a complex gas mixture. After an introduction to this specific technique, we will focused on OF-CEAS based measurements of various species (CO, CH_4, NO, water isotopes...) which have been used in number of interdisciplinary applications and collaborations, notably in the fields of atmospheric chemistry, geosciences and medical breath analysis.

p-number: p251 **Submitted on Tue, 27 Jun 2023 13:06:08 +0200**