COMPARISON OF CAVITY ENHANCED FARADAY ROTATION SPECTROSCOPY TECHNIQUES

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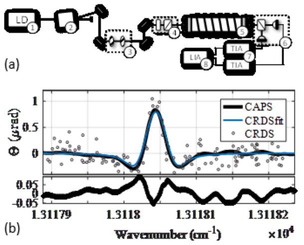

Fig. 1 (a) CAPSFRS setup. (b) FRS measurements of the ${}^{P}P_1(1)$ transition of oxygen measured by CAPSFRS (via LIA) and CRDFRS (via ring-down fitting).

Cavity enhanced absorption techniques derive their sensitivity from an increase in the effective light-matter interaction length provided by a high finesse cavity. However, absorption measurements are often affected by spectrally interfering molecular species, which can hinder selectivity. This issue is addressed by Faraday rotation spectroscopy (FRS), which selectively probes the molecular dispersion of paramagnetic gaseous species (e.g. O_2, NO, NO_2, OH, etc.) subjected to an external magnetic field. Immunity to interfering diamagnetic compounds is thereby obtained allowing reliable quantitative concentration assessments of paramagnetic species in the presence of spectrally interfering molecules, such as H_2O and CO_2. Recently, white-noise limited performance over extended averaging times (minutes/hours) was achieved by combining cavity ring-down (CRD) and FRS. While CRD-FRS provides excellent sensitivities down to noise-equivalent rotation angles of $1.3\text{x}10^{-9}$ rad rtHz^{-1}, it requires fast detectors, high bandwidth digitization electronics and high throughput data analysis which significantly increases the system complexity and cost. To address these limitations, cavity attenuated phase shift (CAPS) FRS and integrated cavity output spectroscopy (ICOS) FRS has been developed. Here, CAPS-FRS ICOS-FRS, and CRD-FRS systems are compared by detecting oxygen at the ${}^{P}P_1(1)$ transition in the A-electronic band around 762.3 nm. The FRS-based techniques are fully self-referencing and require no additional off-resonance calibration, which provides a powerful, yet simple alternative for cavity-enhanced spectroscopy targeting paramagnetic species. The FRS techniques allow for continuous measurements in a line-locked mode, which further increases the system effective duty-cycle and improves the sensing performance. A comparison of long-term system performance, system modeling, as well as system improvements will be presented in detail.

Acknowledgments: The authors acknowledge funding from the National Science Foundation CBET grant #1507358 and from Thorlabs Inc. LP acknowledges the National Science Foundation Graduate Fellowship support.