NOVEL IMPLEMENTATIONS OF FARADAY ROTATION SPECTROSCOPY - FROM IN-SITU RADICAL DETECTION TO STUDIES OF ENVIRONMENTAL NITROGEN CYCLING

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Radical species play an important role in various chemical processes spanning atmospheric chemistry (e.g. ozone formation), bio-medical science, and combustion. These highly reactive chemicals usually occur at very low concentration levels, and are difficult to quantify in experiments[1]. Generally, laser-based techniques rely on careful selection of the target transition to minimize spectral interference and achieve high selectivity. In case of complex gas mixtures (such as air) a possibility of spectral interference always exists. Since Faraday rotation spectroscopy (FRS) is sensitive only to paramagnetic species (radicals), it can simultaneously provide ultra-high sensitivity and selectivity.

In this talk an overview of novel designs of FRS instrumentation as well as applications of FRS sensing will be provided. Examples will be given for FRS systems that routinely operate at the fundamental limits of optical detection, cavity-enhanced FRS detection schemes for sensitivity enhancement towards sub-pptv detection limits[2], and high-accuracy FRS spectrometers designed specifically for ratiometry of nitrogen isotopes (^{14}N, ^{15}N)[3]. Prospects for the FRS technology to monitor important atmospheric molecules such as HOx radicals (atmospheric "cleansing" agents) will be discussed.

References:

1. Wennberg et al., "Aircraft-borne, laser-induced fluorescence instrument for the in situ detection of hydroxyl and hydroperoxyl radicals," Rev. Sci. Instrum. 65, 1858-1876 (1994).
2. Westberg et al., "Optical feedback cavity-enhanced Faraday rotation spectroscopy for oxygen detection," in CES2015(Boulder, CO, 2015).
3. Zhang, "Nitric Oxide Isotopic Analyzer Based on a Compact Dual-Modulation Faraday Rotation Spectrometer," Sensors 15, 25992 (2015).