CORRELATED DOUBLE SAMPLING IN INTRACAVITY LASER SPECTROSCOPY

ALEXANDER A. KACHANOV, DANIELE ROMANINI, *Université J. Fourier/CNRS Grenoble Laboratoire de Spectrométrie Physique BP 87, 38402 Saint Martin d'Hères – France*; ALEŠ CHARVAT, BERND ABEL, *Institut für Physikalische Chemie der Universität Göttingen, Tammannstr.6, 37077 Göttingen*.

Intracavity laser absorption spectroscopy (ICLAS) is a very sensitive high resolution technique. The absorption of the sample placed into the cavity of a broadband laser with a homogeneously broadened absorption medium is enhanced by multiple passages of light inside the cavity. The lasing is periodically interrupted by chopping the beam of the pump laser so that it is quasi-continuous. A short time slice of the output radiation of the laser delayed by the time t_g with respect to the pump interruption is extracted using an acousto-optic modulator and sent to the high resolution spectrograph with a CCD array.

The absorption spectrum of the sample is observed on the envelope of the broadband laser emission spectrum. In addition to its high sensitivity ICLAS provides a certain multiplex advantage since about 1000 spectral elements in a spectral interval 10 to 20 cm^{-1} wide can be recorded in a single measurement. The enhancement of the absorption in ICLAS is due to very large equivalent absorption path length $L_{eq} = c \cdot t_g$. Values of L_{eq} as large as 80,000 km are realized in the experiment.

The detection limit of ICLAS is determined by the noise in the broadband spectral envelope due to the random emission of spontaneous seed photons on the initial stage of the spectrum build-up. This "seed noise" can be as large as 50%, if only one spectrum is detected. Consequently, averaging of a large number of the individual pulses is required in order to obtain low detection limit.

We record two time slices of the same generation pulse with different delays t_{g1} and t_{g2} and take their ratio. Due to the "spectral memory" of the initial distribution this "seed" noise can be significantly suppressed, what permits to realize the ICLAS enhancement in a single pulse experiment. The noise value of 2.5% for the generation time of 400 μs obtained experimentally in a single pulse with 1000 spectral elements recorded simultaneously corresponds to an absorption coefficient of $2 \times 10^{-9}\mathrm{cm}^{-1}$, or to a detectivity of $1.3 \times 10^{-12}\mathrm{cm}^{-1}/\sqrt{Hz}$.