CW CAVITY RING-DOWN: HIGH SENSITIVITY ABSOLUTE ABSORPTION SPECTROSCOPY FROM THE CONTINUUM TO THE SUB-DOPPLER

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Cavity Ring-Down Spectroscopy (CRDS) is one of the most powerful and versatile absorption techniques, which already found several applications in the spectroscopy of weak forbidden transitions and of transient or trace species in jets, flames or discharges. We will discuss recent progresses in our laboratory, which open even more possibilities. In CRDS, after injecting photons into an optical cavity which contains the sample (length ℓ), the cavity losses per pass Λ are measured from the exponential "ringdown time" $\tau = \ell/c\Lambda$ of those photons. If we consider mirror transmittivity T and surface losses L, and the sample absorption coefficient α, then $\Lambda = T + L + \alpha\ell$. Thus, for narrow absorption lines, measurement of the cavity losses while tuning the laser gives the sample spectrum over the slowly varying baseline $T + L$. In standard CRDS, pulsed lasers are used for cavity injection. We obtained substantial advances in this technique by using CW lasers with single–mode cavity–buildup injection[a]. Our CW-CRDS scheme is simple and very robust and works well with grating tuned commercial diode lasers, which will allow building compact CRDS trace detectors for environmental monitoring. With respect to pulsed–CRDS, we improved on the detection limit (10^{-10}/cm) and especially on the spectral resolution ($\sim$1 MHz), which allowed us to obtain high–quality sub-Doppler slit–jet spectra of the weak NO_2 electronic transitions around 780 nm. Finally, in the case of broad absorption spectra, we have demonstrated that the reproducibility of our measurements permits to separately measure the spectral baseline after removing the sample from inside the cavity. The rotationally unresolved (FWHM$\sim$20 cm^{-1}) overtone transition of CHF_3 at 774 nm was used for this demonstration. This proves that CRDS will also be useful for measuring weak absorption continua.

[a] D. Romanini, A. A. Kachanov, N. Sadeghi, F. Stoeckel, Chem. Phys. Lett. 264 (1997) 316