CAVITY RING DOWN WITH PULSED AND CW LASER SOURCES, RECENT DEVELOPMENT AND A LOOK TO THE FUTURE.

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A general introduction to cavity ring down spectroscopy (CRDS) will be given. CRDS methods using pulsed and CW laser sources will be compared in general but also with respect to some interesting applications demonstrated by different research groups.
"Ring down" denotes the exponential decay of photons injected into an optical cavity, which is determined by the cavity losses. When high quality dielectric mirrors are used for the cavity, this ring down is sufficiently long (>100ns) to be comfortably measured and used in determining these (small) losses quantitatively. Indeed, ring down measurements were first employed to measure super-mirror reflectivities using CW laser sources. Afterwards, CRDS developed as a high sensitivity absorption technique and was exploited in various spectroscopic applications with pulsed laser sources.
CRDS will probably remain the simplest and most powerful choice for sensitive absorption measurements with pulsed lasers, which have very large spectral coverage and relatively high resolution. By exploiting the spatial filtering properties of optical cavities, this method can be made totally insensitive to intensity and beam profile fluctuations, a disturbing feature of most pulsed lasers. One of the future goals is controlling mode matching ot the laser beam into the cavity to achieve the shot noise limit with pulsed CRDS.
In the last couple of years, efforts from a few laboratories resulted in the realization of robust schemes for repetitive and efficient injection of CW laser radiation into a ring down cavity. CW-CRDS allows perfectly mode matched cavity excitation and higher repetition rates than usually possible with pulsed lasers. These factors allow to increase the sensitivity by easily approaching the shot noise limit. Also, high intracavity radiation buildup can be exploited for observing nonlinear spectroscopic phenomena. Finally, compact diode laser sources can be used in portable CRDS devices to be employed for remote sensing and trace detection. We note that CW CRDS is also the only high sensitivity method which can give quantitative measurement of unstructured absorptions, such as the scattering by dust produced in plasma rectors or the infrared water vapor continuum.