Cavity Ringdown Spectroscopy of Molecules with kHz Accuracy

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Precise determination of ro-vibrational transition frequencies of molecules is interested for metrology as well as fundamental physics. However, the accuracy of most line positions in the near infrared region is limited to 10^{-3} - 10^{-4} cm^{-1} (~ 1 MHz) due to broadening (Doppler and collision induced) and/or the weakness of overtone transitions. The high-finesse optical cavities used in CRDS not only enhances the detection sensitivity, but also provides a strong laser field which may saturate weak overtone transitions. By measuring the CRDS spectra of molecular Lamb dips, we demonstrate a detection sensitivity (noise-equivalent absorption coefficient) of 10^{-12}/cm and a frequency accuracy of 1 kHz [1]. The method was used to detect extremely weak saturated transitions of HD, towards a determination of the proton-to-electron mass ratio. [2,3] Two-color double resonance (DR) spectroscopy based on continuous-wave diode lasers of milliwatts has also been established [4], which allows us to probe highly-excited states of molecules with unprecedented accuracy [5].

References

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