

DOPPLER BROADENING THERMOMETRY BASED ON CAVITY RING-DOWN SPECTROSCOPY

JIN WANG, YU ROBERT SUN, CUNFENG CHENG, LEI-GANG TAO, YAN TAN, PENG KANG, AN-WEN LIU, SHUI-MING HU, *Hefei National Laboratory for Physical Science at Microscale, University of Science and Technology of China, Hefei, China.*

A Doppler broadening thermometry (DBT) instrument is implemented based on a laser-locked cavity ring-down spectrometer. [1,2] It can be used to determine the Boltzmann constant by measuring the Doppler width of a molecular ro-vibrational transition in the near infrared. Compared with conventional direct absorption methods, the high-sensitivity of CRDS allows to reach satisfied precision at lower sample pressures, which reduces the influence due to collisions. By measuring the ro-vibrational transition of C_2H_2 at 787 nm, we demonstrate a statistical uncertainty of 6 ppm (part per million) in the determined linewidth by several hours' measurement at a sample pressure of 1.5 Pa. [3] However, the complexity in the spectrum of a polyatomic molecule induces potential systematic influence on the line profile due to nearby "hidden" lines from weak bands or minor isotopologues. Recently, the instrument has been upgraded in both sensitivity and frequency accuracy. A narrow-band fiber laser frequency-locked to a frequency comb is applied, and overtone transitions at $1.56\text{ }\mu\text{m}$ of the $^{12}C^{16}O$ molecule are used in the CRDS-DBT measurements. The simplicity of the spectrum of the diatomic CO molecule eliminates the potential influence from "hidden" lines. Our preliminary measurements and analysis show that it is feasible to pursue a DBT measurement toward the 1 ppm precision.

References

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