

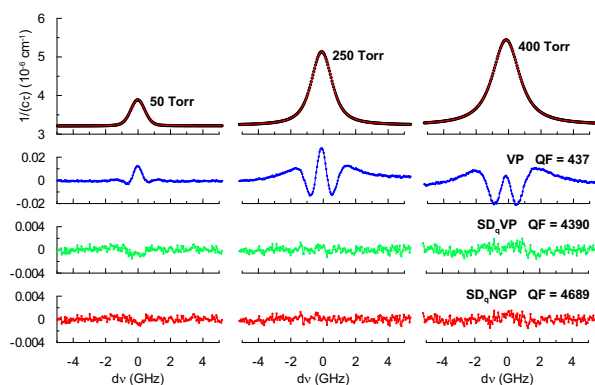
## CRDS investigation of line shapes of the nitrogen-broadened oxygen *B*-band transition

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**Synopsis** We present precise line-shape measurements of the nitrogen-broadened P9 P9 oxygen *B*-band transition occurring near 689 nm. Data were obtained using the optical frequency comb-assisted Pound-Drever-Hall-locked frequency-stabilized cavity ring-down spectrometer. Several line-shape models describing physical effects such as Dicke narrowing, the speed dependence of collisional broadening and shifting, and the correlation between velocity- and phase-changing collisions were used in the analysis. The multispectrum fitting technique is used to minimize correlation between line-shape parameters. Observed line narrowing is mostly determined by the speed dependence of the collisional broadening.

We present here precise line-shape study of the nitrogen-broadened P9 P9 <sup>16</sup>O<sub>2</sub> *B*-band transition. The spectra were measured in a O<sub>2</sub>-N<sub>2</sub> mixture containing 3.00(1)% of O<sub>2</sub>, in wide pressure range (10–400 Torr). Experimental line shapes of oxygen were measured with the optical frequency comb-assisted Pound–Drever–Hall-locked frequency-stabilized cavity ring-down spectrometer (OFC-assisted PDH-locked FS-CRDS) [1]. This setup enables us to achieve high spectral resolution (at kHz level) and high signal-to-noise ratio (exceeding 10<sup>5</sup>) spectra of weak transitions.



**Figure 1.** Measured spectra of the N<sub>2</sub>-broadened O<sub>2</sub> P9 P9 line and residuals from the multispectrum fits of the VP, SDVP, and SDNGP. The value of the quality of the fit (QF) is given for each profile.

In the line-shape analysis we used several models taking into account such physical effects as Dicke narrowing [2], the speed dependence of collisional broadening and shifting [3], and the correlation between the velocity- and phase-changing collisions [4]. The multispectrum fit-

ting technique was used to minimize correlation between line-shape parameters. In Fig. 1 selected measured spectra of the P9 P9 transition are shown with residuals from fits of the Voigt profile (VP), the speed-dependent Voigt profile (SDVP), and the speed-dependent Nelkin-Ghatak profile (SDNGP). It can be seen that commonly used Voigt profile is not sufficient to describe the measured line shapes. Incorporation of the speed-dependent effects to the model improves the QF by an order of magnitude. Taking both the speed dependence and velocity-changing collisions into account in the SDNGP further improves the QF, but only by 7% comparing to the SDVP. All of the speed-dependent profiles give consistent values of the collisional broadening coefficients  $\gamma_L/N$  to within 0.4%. The results for models including only Dicke narrowing differs by up to 1% depending on the velocity-changing collision model. The VP leads to systematic error of about 5%. The analysis revealed that the observed line narrowing is mainly described by the speed dependence of collisional broadening and the influence of Dicke narrowing is not very significant in the investigated case.

### References

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