MULTISPECTRUM ROTATIONAL STATES DISTRIBUTION THERMOMETRY

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We introduce Multispectrum Rotational states Distribution Thermometry (MRDT) as a new optical method for primary thermometry that relies on the global fitting of multiple molecular absorption lines of the same band at different pressures. This allows leveraging the temperature-dependence of the Doppler width and also of the distribution of line intensities across the ro-vibrational band, provided a sufficiently accurate line-strength model is available. We give a preliminary demonstration of the method with a comb-locked frequency-swept cavity-ring-down spectrometer operated on the $3\nu_1+\nu_3$ band of CO_2 located around 1577 nm, which stands out among other spectroscopic samples for the availability of several line intensity models of both experimental and theoretical origin. The spectra signal-to-noise ratio represents the main limitation to a combined uncertainty to 530 ppm, but the comparative analysis between different line-strength models shows promise to reduce the error budget to 33 ppm. As compared to Doppler-broadening-thermometry, an advantage of the approach is the reduced impact of a wrong modelling of the absorption line-shapes. In a reversed approach, MRDT can be applied on a gas of known temperature to set an upper limit to the accuracy of a given line intensity model.