CAVITY RING-DOWN SPECTROSCOPY WITH HETERODYNE DETECTION OF DECAYS

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We present a new approach to the cavity ring-down spectroscopy (CRDS), allowing for fast measurement of both absorption and dispersion of the medium. The dispersion spectra are obtained from a heterodyne measurement of the cavity mode frequency relative to a reference optical frequency locked to the same cavity. This enables high accuracy, in particular, insensitivity to non-linearity of the light detection system, unlike CRDS, which requires linearity calibration at relative uncertainty of absorption of 10^{-3}. Compared to the previously used cavity mode dispersion spectroscopy (CMDS)[1], which uses a static measurement of the cavity transmission spectrum, the new approach is much faster and does not require fine frequency tuning of the sampling laser through the cavity modes. This allows to combine the high accuracy of CMDS[2,3] with the speed of CRDS in a relatively simple optoelectronic system. Moreover, compared to the cavity buildup dispersion spectroscopy (CBDS)[4] our new approach requires lower laser power.

We present the new spectroscopic method on the example of precise measurements of the transition frequencies and intensities of the R23 line from the (3-0) band of CO molecule and P(3) line from the (2-0) band of the HD molecule. To interpret the complex shape of the Doppler broadened and perturbed by collisions HD line, we use the speed-dependent billiard-ball (SDBB) line shape model[5] with calculated ab initio parameters of Dicke narrowing and speed-dependence of the collision broadening and shift[6].

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