LAMB DIP OF A QUADRUPOLE TRANSITION IN H_2

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The NICE-OHMS technique was utilized to measure the saturated absorption spectrum of the hyperfine-less S(0) quadrupole line in the (2-0) band of H_2. This groundbreaking measurement was carried out at $\lambda = 1189$ nm under cryogenic conditions (72 K), marking the first recording of a Lamb-dip for a molecular quadrupole transition. At high intracavity powers ranging from 0.5 to 10 kW, the line shape exhibited a complex profile, akin to previous measurements conducted on HD by our team [1, 2] and by the Hefei team [3].

Interestingly, at low saturation powers (150-200 W), a single narrow Lamb-dip was observed. Further examination revealed that the linewidth of this resonance eliminated the possibility of an underlying recoil doublet of 140 kHz, which would have been anticipated under saturation conditions. Systematic measurements on pressure shifts and power shifts were conducted, and extrapolations to zero levels were fitted. These procedures yielded a transition frequency for the S(0) line of 252 016 361 164 (8) kHz, deviating by -2.6 (1.6) MHz from molecular quantum electrodynamical calculations [4], thus posing a challenge to current theoretical models.

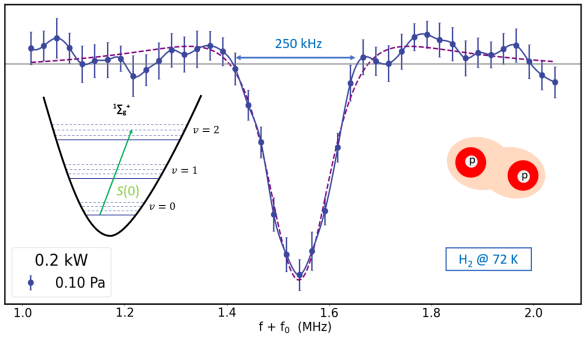

Figure 1: Spectrum of the S(0) quadrupole line of H_2 recorded with NICE-OHMS. The absolute frequency scale, calibrated by a frequency comb laser is given via f0 = 252 016 360 MHz

References

[1] F. M. J. Cozijn, P. Dupré, E. J. Salumbides, K. S. E. Eikema, and W. Ubachs. *Physical Review Letters*, 120:153002, 2018.

[2] M. L. Diouf, F. M. J. Cozijn, B. Darquié, E. J. Salumbides, and W. Ubachs. *Optics Letters*, 44:4733, 2019.

[3] L.-G. Tao, A.-W. Liu, K. Pachucki, J. Komasa, Y. R. Sun, J. Wang, and S.-M. Hu. *Physical Review Letters*, 120:153001, 2018.

[4] J. Komasa, M. Puchalski, P. Czachorowski, G. Lach, and K. Pachucki. *Physical Review A*, 100:032519, 2019.