

Spectroscopy of methanol in the near-infrared at the 10^{-13} level

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This presentation showcases the application of Noise-Immune Cavity-Enhanced Optical Heterodyne Molecular Spectroscopy (NICE-OHMS) for precision spectroscopy of methanol. This approach, invented almost thirty years ago [1] and further developed as an optical precision tool [2], allows the measurement as Lamb-dips of extremely weak transitions [3], combining both sensitivity and accuracy.

We report sub-kHz precision measurements of three vibrational line pairs, corresponding to the $3_{-1}E - 2_0E$ combination difference in the vibrationless ground state. This allows the determination of this 12.2 GHz radio line frequency, highly sensitive to potential variations in the proton-electron mass ratios [4, 5], at kHz precision. Furthermore, having moved our NICE-OHMS setup, I will end this talk by presenting a comparison of results obtained in Amsterdam and Louvain-la-Neuve on these very accurate frequency determination of methanol resonances.

- [1] J. Ye, L-S. Ma, and J.L. Hall, [Opt. Lett. **21**, 1000–1002 \(1996\)](#).
- [2] A. Foltynowicz, F.M. Schmidt, W. Ma, and O. Axner, [Appl. Phys. B **92**, 313–326 \(2008\)](#).
- [3] F. M. J. Cozijn, M. L. Diouf, and W. Ubachs, [Phys. Rev. Lett. **131**, 073001 \(2023\)](#).
- [4] P. Jansen, L.-H. Xu, I. Kleiner, W. Ubachs, and H. L. Bethlem, [Phys. Rev. Lett. **106**, 100801 \(2011\)](#).
- [5] S. A. Levshakov, M. G. Kozlov, and D. Reimers, [Astroph. J. **738**, 26, 26 \(2011\)](#).