HIGH RESOLUTION SPECTROSCOPY USING A TUNABLE THZ SYNTHESIZER BASED ON PHOTOMIXING

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Optical heterodyning, also know as photomixing is an attractive solution as a single device able to cover the entire frequency range from 300 GHz to 3 THz. [a] As the THz frequency is extracted from the difference frequency of two lasers, the accuracy with which the generated frequency is known is directly determined by the frequency accuracy of the lasers. In order to fully characterize the spectral fingerprint of a given molecule an accuracy approximately one order of magnitude finer than the Doppler linewidth is required, around 100 kHz for smaller polar compounds. To generate accurate cw-THz the frequency spacing of the modes of a Frequency Comb (FC) has been employed to constrain the emission frequency of a photomixing source.[b] Two phase locked loops are implemented coherently locking the two cw-lasers (CW1 and CW2) to different modes of the FC. Although this solution allows accurate generation of narrowband THz the continuous tuning of the frequency presents some obstacles. To overcome these difficulties a system architecture with a third cw-laser (CW3) phase locked to CW2 has been implemented. The beatnote between CW2 and CW3 is free from the FC modes therefore the PLL frequency can be freely scanned over its entire operating range, in our case around 200 MHz. The most of polar compounds may be studied at high resolution in the THz domain with this synthesizer. Three different examples of THz analysis with atmospherical and astrophysical interests will be presented:

- The ground and vibrationnally excited states of H_2CO revisited in the 0.5-2 THz frequency region
- The rotational dependences of the broadening coefficients of CH_3Cl studied at high J and K values
- The molecular discrimination of a complex mixture containing methanol and ethanol.

[a] F. Hindle, A. Cuisset, G. Mouret, R. Bocquet *Comptes Rendus Physique*, 2008, **9:** 262-275.
[b] G. Mouret, F. Hindle, A. Cuisset, C. Yang, R. Bocquet, M. Lours, D. Rovera, *Opt. Express*, 2009, **17:** 22031.