High resolution THz instrumentation

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THz waves can be attractive for the analysis of gas phase samples as they are able to provide an excellent discrimination due to the particularly fine Doppler broadening. This frequency range located between the micro-wave and infrared domains is challenging for the construction of instrumentation because of the lack of mature system components such as sources, detectors, filters etc. Nevertheless, over the last two decades the LPCA has focussed its attention on high-resolution THz spectroscopy of gases. Numerous spectrometers have been constructed with the aim to increase the overall performance in terms of sensitivity, spectral coverage, measurement speed and usability. This development has been accompanied by the use of the instruments for both fundamental spectroscopy and numerous applied studies. Several recent advances will be presented and include the use of a resonant cavity gas cell to achieve high sensitivity [1], high resolution spectroscopy with a frequency comb [2], and heterodyne instrumentation [3] which is pushing available frequency range.

[1] C. Elmaleh *et al.*, 'THz cavity ring-down quantitative gas phase spectroscopy', *Talanta*, p. 124097, Nov. 2022, doi: 10.1016/j.talanta.2022.124097.
[2] F. Hindle, A. Khabbaz, A. Roucou, J.-F. Lampin, and G. Mouret, 'Terahertz Frequency Comb High-Resolution Heterodyne Spectrometer', *IEEE Transactions on Terahertz Science and Technology*, vol. 15, no. 4, pp. 566–572, Jul. 2025, doi: 10.1109/TTHZ.2025.3572249.
[3] T. S. Hearne *et al.*, 'Unlocking synchrotron sources for THz spectroscopy at sub-MHz resolution', *Opt. Express*, vol. 30, no. 5, p. 7372, Feb. 2022, doi: 10.1364/OE.448147.