TIME (DO NOT FILL IN)

Performance of the AILES THz-Infrared beamline on SOLEIL for High resolution spectroscopy

Pascale Roy[a] , Jean-Blaise Brubach[a], Mathieu Rouzières[a], Olivier Pirali[b,a], Laurent Manceron[c,a], Didier Balcon[a,b], Fridolin Kwabia Tchana[d,a] , Arnaud Cuisset[e] and Vincent Boudon[f],

[a]*Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin - BP 48, 91192 Gif-sur-Yvette,France*
[b] *LPPM, Orsay, 91405 CEDEX, France,*
[c] *LADIR, U. P. & M. Curie – CNRS, 75252 Paris France*
[d] *LISA, U. Paris XII, Créteil France,*
[e]*Laboratoire de Physico-Chimie de l'Atmosphère, 189A avenue M. Schumann 59140 Dunkerque, France.*
[f] *Institut Carnot de Bourgogne (ICB), Université de Bourgogne, Dijon Cedex France.*

The need for intense and stable broadband THz sources adapted for low throughput experimental methods has long been the motivating factor in the development of new sources. In this context, after the first demonstration of the advantage in brilliance of synchrotron based sources, a significant effort has been devoted to understanding and optimizing the source qualities in the infrared and THz range.

The new THz beamline (AILES) located at the third generation Synchrotron Radiation source SOLEIL benefits from these optimisations and is now operating for applications in a wide variety of research themes. At present, this source with its adapted optics and combined with two spectroscopic stations, allows spectroscopic measurements in the entire infrared and THz range. This presentation will begin by focussing on the performances concerning flux, spectral range and stability for high resolution spectroscopy. We will demonstrate that coupling of synchrotron radiation from a highly stable third generation source with high resolution FTIR spectrometer and with a long path cell (200 m or more) or with an supersonic jet expansion can be particularly advantageous. This fact is related to the optics of the beamline permitting the entire source to be used without aperture stop (entrance iris), even for higher-resolution measurements (10^{-3} cm^{-1}) or ~0.1 µeV).

In the second part of the presentation, the performances will be illustrated using examples of gas phase vibrational studies in the THz frequency range.

We will show, in particular, rovibrational spectra of several organophosphorus (alkyl phosphates and alkylphosphonates) and organosulphide compounds (alkyl sulfoxyde). Using *ab initio* calculations, a full assignment of the spectra will be presented, highlighting the discrimination amongst these molecules and new structural information.

In addition, we will present the first high resolution measurement of the pure rotational spectrum of methane (CH_4) - This small molecule is present in many planetary atmospheres, including that of the Earth (where it has a powerful green-house effect). Due to its symmetry, the methane molecule does not possess a permanent dipole moment. Centrifugal distortion can, however, induce a very weak pure rotational spectrum. Although crucial for planetology, as it allows the determination of the quantity of methane in planetary atmosphere, this measurement was still lacking so far. Thanks our recent synchrotron radiation measurements, the first reference rotational spectrum of methane are available for interpreting data obtained in present and future space missions.

Finally, we will present recent developments on the ring operation allowing the detection of an intense THz beam produced by shortening the electron bunches (low α mode) although, so far, the stability of this operation mode prevents from exploiting it for high resolution experiments.