

Probing rarefied gas expansions by direct absorption FTIR spectroscopy

Robert Georges

Institut de Physique de Rennes, UMR 6251 CNRS-Université de Rennes 1, Campus de Beaulieu, Bât.11C, 5042 Rennes Cedex, France, Tel : + 33 2 23 23 67 53, E-mail : robert.georges@univ-rennes1.fr

Thanks to its broad spectral coverage and adjustable spectral resolution, continuous supersonic-jet Fourier transform infrared (FTIR) spectroscopy is an interesting experimental approach for tracking the formation of weakly bound clusters [1] and aggregates [2,3], or for simplifying the rotation-vibration spectrum of large and heavy molecules [4,5]. Although laser-based approaches are intrinsically more sensitive, Jet-FT spectrometers are still competitive when coupled to high-throughput slit- or *de Laval* nozzles, which then assumes a well-controlled injection of vapour from possibly liquid, or even solid, samples in standard conditions. Moreover, the use of non-coherent light sources offers remarkable panoramic vision on the vibrational bands in the mid infrared region. Such a set-up is used at IPR to control the formation of nanometric / sub-micrometric size aggregates.

Recently, groups from the IPR, LADIR (P. Asselin, P. Soulard) and PhLAM (M. Goubet, T.R. Huet) have developed the Jet-AILES apparatus coupling a slit jet device to the high-resolution FT spectrometer of the AILES beamline (O. Pirali, P. Roy) at the synchrotron light source SOLEIL, opening access to very low wavenumbers, in the far infrared domain. The former objective being the investigation of low-lying vibrational modes of molecular complexes and large molecules. Several studies of molecular systems in the mid and far infrared, including the oxirane-water complex [6], the HF trimer [7] and the acetic acid and its dimer [8], highlight the potential and the versatility of this set-up whose advantages and limitations will be discussed.

[1] V. Chandrasekaran, L. Biennier, E. Arunan, D. Talbi, R. Georges, Direct Infrared Absorption Spectroscopy of Benzene Dimer *J.Phys.Chem.A* **2011**, 115, 11263-8.

[2] A. Bonnamy, R. Georges, A. Benidar, J. Boissoles, A. Canosa, B.R. Rowe, Infrared spectroscopy of (CO₂)_N nanoparticles, 30<N<14500, flowing in a uniform supersonic expansion *J.Chem.Phys.* **2003**, 118, 3612-3621.

[3] A. Moudens, R. Georges, M. Goubet, J. Makarewicz, S.E. Lokshantov, A.A. Vigasin, Direct absorption spectroscopy of water clusters formed in a continuous slit nozzle expansion, *J.Chem.Phys.* **2009**, 131, 204312.

[4] V. Boudon, P. Asselin, P. Soulard, M. Goubet, T. R. Huet, R. Georges, O. Pirali, P. Roy, High-resolution spectroscopy and analysis of the $\nu_2 + \nu_3$ combination band of SF₆ in a supersonic jet expansion, *Mol. Phys.* **2013**, DOI:10.1080/00268976.2013.793888

[5] O. Pirali, M. Goubet, T.R. Huet, R. Georges, P. Soulard, P. Asselin, J. Courbe, P. Roy, M. Vervloet, The far infrared spectrum of naphthalene characterized by high resolution synchrotron FTIR spectroscopy and anharmonic DFT calculations, *Phys. Chem. Chem. Phys.* **2013**, 15, 10141-10150

[6] M. Cirtog, P. Asselin, P. Soulard, B. Tremblay, B. Madebène, M.E. Alikhani, R. Georges, A. Moudens, M. Goubet, T.R. Huet, O. Pirali, P. Roy, The (CH₂)₂O-H₂O hydrogen bonded dimer. Ab initio calculations and FTIR spectroscopy from neon matrix, and a new supersonic jet experiment coupled to the infrared AILES beamline of synchrotron SOLEIL *J.Phys.Chem.A* **2011**, 115, 2523-2532.

[7] In preparation

[8] In preparation