HOW CAN SYNCHROTRON-BASED FTIR SPECTROSCOPY CONTRIBUTE TO ASTROPHYSICAL AND ATMOSPHERIC DATA NEEDS?

A.R.W. McKELLAR, *Steacie Institute for Molecular Sciences, National Research Council of Canada, Ottawa, ON K1A 0R6, Canada.*

Following the pioneering demonstration of gas-phase IR spectroscopy using synchrotron radiation (SR) at MAXLab and LURE, a number of new high resolution IR beamline facilities have recently become available, including those at the Canadian Light Source, the Australian Synchrotron, and Synchrotron SOLEIL. The high brightness of SR compared to conventional thermal sources gives potential signal gains of 2 to 3 orders of magnitude for this difficult region, though noise (e.g. from mechanical vibration) remains a problem.

For astrophysical applications, comprehensive studies which involve measuring many thousands of transitions are needed for molecules ubiquitous in space (like methanol). Here the multiplex nature of FTIR spectroscopy is advantageous compared to the line-by-line nature of conventional microwave measurements. But is the accuracy sufficient? In recent Canadian Light Source spectra with line widths of 20 MHz and reasonable signal-to-noise ratio, line centers are routinely measured to better than 1 MHz. So it should be possible to approach the accuracy required by radio astronomers. Another astrophysical need is for improved data on unstable species (radicals and ions). Here the broad-band nature of FTIR helps with the search problem, and the high resolution possible with SR helps with sensitivity. But coherent (microwave or laser) sources may give better ultimate sensitivity. As well, synchrotron users face the challenge of creating unstable molecules (difficult enough in their own laboratory!) at the beamline where they may have only a few days of access.

For terrestrial remote sensing, we wish to have complete and detailed spectral data for atmospheric molecules and potential pollutants. The availability of new synchrotron facilities will certainly help in this respect, particularly for the 50 - 500 cm^{-1} range where coverage has been relatively limited. The required data are not limited to line positions. Detailed line shape information is also needed for a range of gas pressure, temperature, and mixture composition, in order to extract line broadening, shift, and mixing parameters. High spectral resolution and the multiplex nature of FTIR are advantageous, but, once more, the challenge is to establish the required sample conditions (precise, well-characterized pressure, temperature, path length, etc.) in the remote beamline laboratory.