THz/Far-IR FT-spectroscopy with a Synchrotron Source: A High-sensitivity Tool to Investigate Broadband Rotational Spectra of Interstellar Molecular Species in the Laboratory

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A THz/Far-IR beamline with high spectral resolution capabilities has been constructed at the Australian Synchrotron. The THz/Far-IR beamline is coupled to a Bruker IFS125HR FT spectrometer equipped with a variety of optical components covering the spectral range from 10 to 1000 cm^{-1}; this instrument can offer an optimum unapodized resolution of 0.00064 cm^{-1} (or ~ 20 *MHz*). Experiments from a variety of fields such as atmospheric and astrophysical science, geology, as well as biology and biomedicine have been successfully conducted at the beamline.

A range of instruments have been installed in order to accommodate the scientific requirements of Users: two room-temperature gas cells with multiple-pass optics, one for non-reactive species and one coupled to a furnace to study reactive species; there is also a multiple-pass gas cell which can be cooled to liquid N_2 and liquid Helium temperatures in order to study *supercooled* gases and molecular clusters. Users also have access to a cryostat to study condensed phase systems, and a grazing incidence angle accessory to study thin films.

The synchrotron infrared light offers a S/N advantage over conventional thermal sources. This advantage varies to a great degree depending on the spectral region and the resolution required by the experiment. In this paper, the beamline and its performance will be presented as well as some of the interstellar molecular species studied, and future beamline developments that will be undertaken to enhance the performance in the THz region.