SUBMILLIMETER WAVELENGTH FOURIER TRANSFORM SPECTROSCOPY OF ASTRONOMICAL SOURCES

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At high, dry observatory sites, the transmission of the atmosphere at near-millimeter and submillimeter wavelengths provides access to frequency "windows" which encompass roughly half a terahertz of bandwidth. Broadband spectroscopic techniques, such as Fourier transform spectroscopy, provide an effective means of exploring these vast tracts quickly, being especially useful for studies of wideband source spectra, and broad-line sources. As is outlined here, the former is applicable to studies of the interstellar medium, while the latter is particularly useful for planetary spectroscopy.

In the tropospheres of the giant planets, pressure broadened absorption lines with widths of several GHz can be expected. Figure 1 shows a spectrum of Jupiter in the highest frequency submillimeter atmospheric window, measured with a Fourier transform spectrometer (FTS) at the Caltech Submillimeter Observatory (CSO). Evident immediately is a strong and wide ($\approx$ 10 GHz FWHM) absorption due to the 3-2 band of PH_3, a molecule very useful in tracking vertical transport in the upper troposphere.

As regards the interstellar medium, it is perhaps surprising that twenty five years after the detection of CO in the interstellar medium, wideband millimeter/submillimeter emission line spectra of even well-studied sources have yet to be measured. With an FTS, such wideband measurements are straightforward, and Figure 2 presents the near-millimeter and submillimeter spectrum of the OMC-1 cloud core measured with 0.2 GHz resolution. Five optically thick transitions of CO are evident in the spectrum, and, as Figure 3 shows, a total of over 180 spectral features have been detected. Interestingly, the CO molecule does not dominate the integrated subterahertz line flux emerging from the cloud core; rather, the shock enhanced S-bearing SO_2 and SO molecules account, respectively, for the largest and next-largest energy fluxes, with CO in third place.

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Figure 1. The high frequency spectrum of Jupiter, measured at a spectral resolution of 0.2 GHz with a Fourier Transform Spectrometer at the CSO.

Figure 2. The broadband spectrum of OMC-1 measured with the same FTS.

Figure 3. An expanded version of the Orion spectrum of Fig. 2.