TERAHERTZ SPECTROSCOPY OF MOLECULES IN THE INTERSTELLAR MEDIUM AND AROUND STARS – SURE BETS AND CHALLENGES

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In the very near future, powerful new observatories will revolutionize broad band astronomical spectroscopy at THz frequencies. These include the Herschel Space Observatory, the Atacama Large Millimeter Array and, at somewhat lower, GHz, frequencies the Expanded Very Large Array. The latter two, "radio"-style interferometers will allow sub-arcsecond, high spectral resolution imaging with total instantaneous observing bandwidths up to 100 times larger than present day facilities. This will allow comprehensive multi-transition/multi species studies that offer new approaches to a variety of astrophysical/chemical areas all of which are dependent on the availability of extensive laboratory data.

To give a few examples: For many interesting sources it will be possible to get a complete astrochemical "fingerprint" in a single observing session with high-quality images of the distributions of the individual species! Targets include the extremely molecule-rich hot molecular cores around protostellar objects and emission from vibrationally excited lines from the innermost circumstellar envelopes of nearby asymptotic branch branch stars which will be imaged with a resolution better than the stellar diameter.

Complete, high spectral resolution scans of various keystone objects over the whole 480–1250 and 1410–1920 GHz ranges will be conducted by the Heterodyne Instrument for the Far-Infrared (HIFI) aboard Herschel. These include lines from various important hydride species and, importantly, water vapor that are not observable from the ground.

Organic molecules have hundreds of GHz/THz lines. However, due to the generally low abundances and large partition functions of "new" (yet to identified) very complex species, all of these are weak and have to be picked out of a thicket of also weak rotational lines from within relatively low energy vibrationally excited levels from various isotopologues of known species. Here, comprehensive model spectra of *all* the species known to exist in a source have to be constructed to "weed out" the contaminants. This requires comprehensive laboratory data, which as of now is far from existing. Moreover, Herschel will allow access to types of transitions, e.g., vibrational ones from carbon chain species, for which spectroscopic data has yet to be obtained.

I shall give an overview of the challenges and great opportunities of astronomical molecular spectroscopy in the coming years and the crucial role of laboratory spectroscopy.