MILLIMETER-WAVE SPECTROSCOPY OF METAL-CONTAINING MOLECULES: A DECADE OF BLOOD, SWEAT AND TELESCOPES

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Metal-containing molecules are important in a wide variety of areas, including organic synthesis, catalysis, chemical vapor deposition and in biology. They also play a significant role in interstellar chemistry, where they trace the unusual physical and chemical processes during the later stages of stellar evolution. Therefore, high-resolution measurements of the gas-phase spectra of metal-containing species impact on many fields, providing structural information, bonding characteristics and the necessary "rest-frequencies" for radio astronomical observations.

For over a decade, the Ziurys group has been recording pure-rotational spectra of transient metal-bearing species using millimeter/submillimeter direct absorption techniques. These molecules have been created through the gas-phase reaction of the metal vapor, produced by a modified Broida oven, with an appropriate precursor. Metals of particular interest have included lithium, sodium, magnesium, potassium, calcium, aluminum, and the 3d transition metals, combined with a variety of simple ligands such as OH, CN, CCH, CH_3, NH_2, and even carbon and nitrogen atoms. Several of the molecules investigated are common organic reagents such as $LiCH_3$, $NaNH_2$ and CuCN; others are short lived free-radicals with high-spin ground states, e.g. MnF ($^7\Sigma^+$), CoCN ($^3\Phi_i$) and NaC ($^4\Sigma^-$), some of which exhibit Renner-Teller splittings or quasi-linear effects in vibrationally excited states. A large fraction of these molecules are also of astrophysical interest and have been studied in interstellar/circumstellar gas. In this talk, the interesting chemistry and spectroscopy of these species will be discussed. In addition, implications of recent astronomical identifications will be summarized.