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Probing the Molecular Universe with Rotational Spectroscopy: A Laboratory and Observational Perspective[1]

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Astrophysical observations over the past 40 years have clearly revealed that much of interstellar space is molecular in content, with a rich chemical composition. To date, over 180 different chemical compounds have been identified in interstellar gas, ranging from diatomic molecules to large carbon clusters, with many exotic radicals and ions. A key factor in these studies has been pure rotational spectroscopy, which enables molecule identification on the basis of a distinct "fingerprint," first measured in the laboratory and then at radio/millimeter telescopes. The Ziurys group has been pursuing a joint program of laboratory measurements and astronomical observations of possible new gas-phase interstellar molecules. Our experimental work involves millimeter/sub-mm/THz spectroscopy, and well as Fourier transform microwave/mm-wave techniques. As reactive species are generally studied, unusual molecule production techniques involving lasers, electrical discharges, ovens, and supersonic jet expansions are employed. Our current studies focus on diatomic hydride radicals such as FeH and SH^+, small metal-carbon clusters, including AlC_2 and ScC_2, and more "organic"-type molecules such as CH_3NCO. Astronomical searches have been carried out for many of these molecules at millimeter telescopes, with some surprising results.

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