"Chemistry Among the Stars: The Unexpected Molecular Environment Beyond Earth"

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Astronomical observations over the past 40 years has revealed regions of interstellar space that are, quite surprisingly, rich in molecular material. Over 180 different chemical compounds have now been securely identified in interstellar gas, most of which contain carbon. Furthermore, the degree of molecular complexity appears to be increasing with the recent identifications of C_{60},C_{70}, and C_{60}^+ in interstellar material. What unexpected molecules will next be discovered? In addition, molecular material is now being found in some of the most extreme interstellar environments, such as near dying white dwarf stars or at the very edges of our Galaxy. A picture is now emerging of a truly *molecular* universe.

The extent of what can be learned, however, is largely limited by laboratory molecular spectroscopy, which produces the crucial "fingerprint" for astronomical observations. High resolution, rotational techniques are particularly important in this regard. Using a combination of Fourier transform microwave (FTMW), millimeter direct absorption, and Terahertz spectral methods, we have been measuring the pure rotational spectra of potential interstellar molecules. A major focus has been the study of small, highly reactive species containing metals, including cyanides, carbides and dicarbides, and monoacetylides, including FeCN, ScC_2, and AlC_2. Simple hydrides are another area of interest, including FeH and SH^+. Unusual gas-phase synthetic methods are required to create such molecules, with the use of lasers, electrical discharges, and supersonic expansions. This unusual laboratory work will discussed, as well as the astrophysical implications.