Molecular Spectroscopy in AGB star envelopes

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The envelopes expelled by AGB stars play a crucial role in the regeneration of the interstellar medium and its enrichment in heavy elements and grains. These envelopes are also the sites of formation of a large variety of molecules, which range from acetylenic chains to metal-bearing radicals. Because of this wealth of interstellar-type molecules, and because the physical conditions and time-scales in the envelopes are well known, AGB stars stand out as unique laboratories for the study of astrochemical processes.

Two-thirds of the known interstellar molecules are observed in the envelopes of AGB stars. Most of them were found by surveying the mm-wave spectra of the nearby C-rich envelopes IRC+10216, CRL 618, and CRL 2688. The number of reactive species in these envelopes is stunning; as a matter of fact, many radicals have been discovered in IRC+10216, the closest of these stars, prior to be observed in a spectroscopic laboratory. MM-wave observations, however, are sensitive only to polar molecules, and our knowledge of the envelope chemical composition is partial. ISO, which has recently surveyed the infrared spectra of these objects, has greatly contributed to correct this bias by revealing the presence of polyacetylenes, and, even, of benzene. These latter species are not observed in IRC+10216, but in CRL 618, a more evolved object. The presence of benzene in CRL 618 may yield clues to the formation of PAHs and small graphitic grains in the diffuse, unshielded envelopes surrounding planetary nebulae.

HIFI/FIRST, which will bridge the frequency gaps left by ISO/LWS and ground-based submm observations, will yield the first complete high resolution spectra of these objects. At the longest wavelengths surveyed by ISO, it will also provide an important gain in sensitivity and spectral resolution. Of special interest will be the access to the rotational lines of new, light molecules, such as the simple hydides, and the study of the shapes of high excitation lines, which trace the dust and wind formation regions.