Molecular Carbon in the Galaxy: New Laboratory and Observational Studies

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The possible roles of two distinct forms of carbon in the ISM is being explored. Polycyclic Aromatic Hydrocarbon (PAH) molecules, proposed as UIR carriers are studied in the gas phase by IR emission spectroscopy, while pure carbon clusters are studied by a combination of IR cavity ringdown spectroscopy, FIR laser spectroscopy, and observational FIR astronomy.

We have developed an infrared photon counting method based on a blocked impurity band solid state photomultiplier (BIB-SSPM) for the purpose of measuring IR emission spectra of large PAH molecules under conditions approximating those in the Interstellar Medium. We have recently [1] used this new technique (single photon infrared emission spectroscopy, SPIRES) to measure gas phase IR emission from a number of UV laser-excited neutral PAHs over the entire spectral range of the UIRs. Apart from the 3.3 μm feature, no acceptable matches with UIR features were found. Here, we describe the extension of SPIRES to PAH cations, generated and observed in a well-characterized ion beam.

We have reported [2] the first observation of infrared emission from a gaseous ionic polycyclic aromatic hydrocarbon (PAH), the pyrene cation, over the range of wavelengths spanned by the UIRs. The complete set of pyrene cation IR emissions is observed, with relative intensities consistent with astrophysical observations, thus supporting the proposal that ionized PAHs are major contributors to the UIR bands. Additionally, unidentified features possibly arising from dehydrogenated PAH species are noted in the spectrum.

Neutral carbon clusters as large as C13 have been studied in our laboratory by high resolution IR diode laser spectroscopy.[3] We have now developed a new IR cavity ringdown technique capable of higher sensitivity, much broader spectral coverage, and similar spectral resolution relative to a diode laser spectrometer, as demonstrated in a study of the C9 cluster.[4]

Meanwhile, our initial detection of the C3 molecule in the source Sg B2 was confirmed by the ISO study of Charnicharo *et al.*, demonstrating the potential for detecting such nonpolar species via their low-frequency bending vibrations.

References:

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[4] T.F. Giesen, A.O. Van Orden, J.D. Cruzan, R.A. Provencal, R. Gendriesch, F. Lewen, G. Winnewisser, R.T. Boreiko, A.L. Betz, and R.J. Saykally, *Astrophys. J. Lett.* **551], L181-L184 (2001).**