DIBSyRCH:
The Diffuse Interstellar Band Synchrotron Radiation Carrier Hunt: Naphthalene Clusters

M. H. Stockett, M. P. Wood, and J. E .Lawler*
University of Wisconsin, Department of Physics, Madison, WI 53706, USA
**stockett@wisc.edu*

The identity of the carrier molecules of the Diffuse Interstellar Bands (DIBs) is the most durable mystery of spectroscopic astronomy. The DIBs are persistent absorption features, >300 total, observed along many lines of sight through the Interstellar Medium (ISM). The DIBs are scattered throughout the visible and near infrared, with widths in the 2 - 100 cm^{-1} range. For nearly a century, laboratory spectroscopists have struggled to match astrophysical wavelengths to laboratory wavelengths of known molecules including a variety of stable molecules, radicals, cations, and anions. Many researchers have hypothesized that hydrocarbon molecules are responsible for the DIBs, due to the rich chemistry and high cosmic abundance of carbon and hydrogen. Though large Polycyclic Aromatic Hydrocarbons (PAHs) are now suspected to be the source of the DIBs, no definitive matches have yet been made to laboratory PAH spectra. Aromatic clusters are also thought to be an important constituent of the interstellar dust distribution and may contribute to the 2175 A "bump" in the interstellar extinction curve. The Diffuse Interstellar Band Synchrotron Radiation Carrier Hunt (DIBSyRCH) experiment has been built at the Synchrotron Radiation Center (SRC) to test these hypotheses by conducting a spectroscopic survey of a broad range of cold, gas phase and clustered PAH molecules and ions.

Using a custom echelle spectrograph and the innovative Cryogenic Circulating Advective Multi-Pass (CCAMP) absorption cell, we routinely achieve a detection sensitivity to molecular densities on the order of 10^7 cm^{-3} with a signal-to-noise ratio of 10,000 in 60 seconds of data collection in the visible. This instrument, coupled with the high spectral radiance of the synchrotron radiation continuum from the SRC's White Light Beamline, permits rapid acquisition of spectra covering broad wavelength regions with resolution appropriate for the DIBs.

In order to obtain astrophysically relevant spectra of low-temperature PAHs, the molecules are entrained in a flow of cold neon buffer gas inside the CCAMP cell. A multi-pass optical cavity using special high-reflectivity broadband mirrors extends the absorption pathlength to hundreds of meters. A capacitively coupled RF dielectric barrier discharge is used to indirectly ionize the PAHs. The CCAMP cell combined with the broad spectral coverage and high spectral radiance of synchrotron radiation make this experiment uniquely suited to the DIB carrier search.

Low-temperature spectra of naphthalene clusters will be presented. The CCAMP absorption cell is a unique tool for studying such PAH clusters in a low-temperature dusty-discharge environment. This work will produce new insights into the role of PAH clusters in the ISM and their contribution to interstellar extinction.