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The Enigmatic Diffuse Interstellar Bands: A Reservoir of Organic Material

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The diffuse interstellar medium of our galaxy contains about 3 billion solar masses of atomic hydrogen, or $\sim 3 \times 10^{66}$ H atoms. The inventory of identified heavy-atom-containing molecules in diffuse clouds includes CH, CH^+, NH, OH, C_2, CN, C_2H, and C_3H_2, and totals to roughly $\sim 10^{59}$ in number. However, a ubiquitous set of optical absorption lines known as the diffuse interstellar bands (DIBs) belies the likely presence of $\sim 10^{58}$ large organic molecules that have yet to be identified. The first of the DIBs were observed in 1919, but despite many decades of intensive efforts by laboratory spectroscopists and astronomers the identities of the molecular carriers of the DIBs remain a mystery. After reviewing the history of the DIBs, I will discuss some preliminary results from a large-scale DIBs observing campaign that was conducted on over 119 nights between 1999 and 2003, using the 3.5-meter telescope at the Apache Point Observatory. This survey, undertaken by a collaboration led by Don York at the University of Chicago, has produced high-resolution, high signal-to-noise ratio spectra of over 160 stars, spanning the entire optical region from 3600–10200 Å. In particular, I will focus on two ongoing efforts. The first is the generation of a comprehensive spectral atlas of the DIBs based on four heavily reddened sightlines; this atlas will be of great use to spectroscopists who wish to compare their laboratory spectra to interstellar spectra (in hopes of finding a match!). The second is the search for correlations among the different DIBs, and especially the search for sets of DIBs that always have the same relative intensities in different sightlines. Such sets would represent the electronic spectra of individual molecular carriers of the DIBs, and could provide hints about which species should be considered for additional laboratory spectroscopic studies.