ESO Diffuse Interstellar Bands Large Exploration Survey (EDIBLES) – Merging Observations and Laboratory data

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The Diffuse Interstellar Bands (DIBs) are a set of ~500 absorption bands that are detected in the spectra of stars with interstellar clouds in the line of sight. DIBs are found from the NUV to the NIR in the spectra of reddened stars spanning different interstellar environments in our local, and in other galaxies. DIB carriers are a significant part of the interstellar chemical inventory. They are stable and ubiquitous in a broad variety of environments and play a unique role in interstellar physics/chemistry. It has long been realized that the solving of the DIB problem requires a strong synergy between astronomical observations, laboratory astrophysics, and astrophysical modeling of line-of-sights.

PAHs are among the molecular species that have been proposed as DIB carriers. We will present an assessment of the PAH-DIB model in view of the progress and the advances that have been achieved over the past years through a series of studies involving astronomical observations of DIBs, laboratory simulation of interstellar analogs for neutrals and ionized PAHs, theoretical calculations of PAH spectra and the modelization of diffuse and translucent interstellar clouds. We will present a summary of what has been learned from these complementary studies, the constraints that can now be derived for the PAHs as DIB carriers in the context of the PAH-DIB model and how these constraints can be applied to the EDIBLES project. The spectra of several neutral and ionized PAHs isolated in the gas phase at low temperature have been measured in the laboratory under experimental conditions that mimic interstellar conditions and are compared with an extensive set of astronomical spectra of reddened, early type stars. The comparisons of astronomical and laboratory data provide upper limits for the abundances of *specific* neutral PAH molecules and ions along *specific* lines-of-sight. Something that is not attainable from infrared observations alone. We present the characteristics of the laboratory facilities, MIS and COSmIC, that have been developed for this study and discuss the findings resulting from the comparison of the laboratory data with high resolution, high S/N ratio astronomical observations. MIS stands for Matrix Isolation Spectroscopy, a well-proven technique for isolating cold molecular species in inert solid environments. COSmIC stands for Cosmic Simulation Chamber. It combines a supersonic free jet expansion with discharge plasma and high-sensitivity cavity ringdown spectroscopy and time-of-flight mass spectrometry detection tools for the generation and the detection of cold, isolated gas-phase molecules and ions under experimental conditions that closely mimic interstellar conditions. The column densities of the individual neutral PAH molecules and ions probed in these surveys are derived from the comparison of these unique laboratory data with high resolution, high S/N ratio astronomical observations. The comparisons of astronomical and laboratory data lead to clear and unambiguous conclusions regarding the expected abundances for PAHs of various sizes and charge states in the interstellar environments probed in the surveys. Band profile comparisons between laboratory and astronomical spectra lead to information regarding the molecular structures and characteristics associated with the DIB carriers in the corresponding lines-of-sight. These quantitative surveys of neutral and ionized PAHs in the optical range open the way for unambiguous quantitative searches of PAHs and complex organics in a variety of interstellar and circumstellar environments.

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