

EXPLORING THE IMPORTANCE OF INTERSTELLAR IONS IN THE ENIGMA OF DIFFUSE INTERSTELLAR BANDS

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Abstract. Diffuse Interstellar Bands (DIBs), hundreds of absorption features observed in interstellar space, were discovered a century ago by Mary Lea Heger (see Heger 1922). Identifying their origins has been a persistent challenge. Although five near-infrared DIBs are attributed to the fullerene cation C_{60}^+ (see (Campbell *et al.* 2015; Walker *et al.* 2015), the carriers of over 600 visible and near-infrared DIBs remain unknown. Solving this puzzle would enhance our understanding of the carbon cycle in space, crucial for modeling stellar chemistry and the processes in planetary atmospheres and surfaces that may lead to life. There is a general consensus that DIB carriers are large gaseous carbon molecules (containing 10 to 100 carbon atoms), existing mainly in cationic forms.

Ions are typically studied using action spectroscopy, which offers greater sensitivity than conventional absorption spectroscopy by detecting photo-induced processes and counting charged particles via mass spectrometry. However, action spectroscopy struggles with obtaining undisturbed spectra, limiting its ability to determine band centers and relative intensities. Direct spectroscopy provides absolute wavelength transitions but lacks sensitivity due to low ion density. Cavity ringdown spectroscopy (CRDS) enables reaching kilometers of absorption lengths, greatly enhancing sensitivity. We propose combining action and direct spectroscopy in a single instrument, utilizing CRDS to measure spectra of trapped, cold, isomer-specific ions. This approach aims to contribute to the evaluation of the carbon budget in space, addressing the knowledge gap, through the DIBs puzzle, regarding molecules with 11 to 60 carbon atoms that remain elusive in the interstellar medium (see Fig. 1.)

