Testing PAH Emission Models: Constraining Size and Ionization in Reflection Nebulae

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Polycyclic aromatic hydrocarbon (PAH) molecules exhibit distinct emission bands across various wavelengths in the infrared, revealing their prevalence throughout the Universe. Their excitation is dependent on the spectral shapes or "hardness" of the illuminating starlight. Typical reflection nebulae, of which the central illuminating stars span a wide range of effective temperatures from 3000 to over 20000 K, provide an ideal laboratory for studying the excitation of PAH emission by starlight of various spectral shapes. Focusing on a sample of characteristic reflection nebulae, including vdB 17, vdB 59, vdB 101, and vdB 133, and utilizing the single-photon heating model, we calculate the theoretical PAH emission to explore how PAH properties vary with these different radiation environments. Specifically, we use the major emission features at 6.2, 7.7, and 11.3 micron derived from these model spectra to construct diagnostic band-ratio grids. By placing the observed band ratios in the grids, we can determine the size and charging properties (i.e., ionization fraction) of PAHs and examine how they vary with the local environments. This study sheds light on the nuanced relationship between PAH excitation and starlight spectrum, offering insights into the broader understanding of the physics and chemistry of PAHs in the interstellar medium.