PAH Emission in the Andromeda Galaxy: Probing its Dependence on Starlight Spectrum

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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 spectrum or “hardness” of the illuminating starlight.

The Andromeda galaxy (M31), of which the nucleus, bulge, active star-forming rings, and quiescent inter-ring regions are characterized by different starlight “hardnesses”, provides an ideal laboratory for studying the excitation of PAH emission by starlight of various spectral shapes.

Utilizing data from Spitzer/IRS, alongside GALEX and SDSS broadband photometry, we construct the starlight spectrum for each region from the far ultraviolet (UV) to the near infrared (IR). We then explore how PAH excitation in M31 varies across different environments, from the UV-bright star-forming rings to the UV-poor bulge and inter-ring areas. Our findings support the earlier studies of Li & Draine (2002) and Mattioda et al. (2005) that the excitation of PAHs does not require UV photons and PAHs can be excited sufficiently to emit in the IR by 'soft' photons. By comparing the model emission spectra of PAHs in various regions of M31 with the astronomical spectra observed by ISO and Spitzer, we determine the size and charging properties of PAHs and examine how they vary across M31. 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 galaxies.