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Probing the Size Distribution of PAHs in Reflection Nebulae

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The mid-infrared (MIR) spectrum of many astronomical sources show prominent emission features at 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm attributed to the IR fluorescence of polycyclic aromatic hydrocarbons (PAHs). We use spatial maps of the 3.3 and 11.2 μm PAH emission features to measure the distribution of PAH size within two reflection nebulae with strong MIR emission present, namely NGC 2023 and NGC 7023. Variations in the size of these molecules with distance from a source of ultraviolet (UV) radiation is indicative of the photochemical evolution of these species and yields information on how they interact with their environment.

We make use of the First Light Infrared TEst CAMera (FLITECAM) on board the Stratospheric Observatory for Infrared Astronomy (SOFIA) to observe the 3.3 μm emission in each source. The 11.2 μm emission band is measured using spectral maps obtained from the Infrared Spectrograph (IRS) SH mode on board the Spitzer Space Telescope. Additionally, we use broadband photometry at 8 μm from the Infrared Array Camera (IRAC) on board Spitzer. These IRAC 8 μm images are compared with the IRS SH data to map the 8 μm over 11.2 μm ratio, as an approximate measure of the PAH ionization state.

We use the map of the 11.2 μm over 3.3 μm emission feature to probe the size distribution in each of our sources. We find that this ratio is at a minimum on the surface of the photodissociation region (PDR) and increases by a factor of 2-3 moving inwards towards the illuminating source in both reflection nebulae, suggesting these species undergo significant photoprocessing within their environment. We also note that the ionization level of these species is found to increase with decreasing distance to the illuminating source in both of these cases. Hence, we can infer there is evidence of a rich carbon-based chemistry driven by the photochemical evolution of the omnipresent PAH molecules within the interstellar medium.

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Yes

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