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Aliphatic Features in Mid-Infrared Polycyclic Aromatic Hydrocarbon Spectra

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The mid-IR spectra of almost all objects are dominated by strong emission bands at 3.3, 6.2, 7.7, 8.6, and 11.3 micron due to Polycyclic Aromatic Hydrocarbon molecules (PAHs). It is now well established that these mid-IR bands show clear variations in shape and peak position from one point source to another, as well as varying spatially within extended sources. The spectral diversity of the PAH band profiles reveals the nature of the carriers and hence allows one to study their formation and evolution throughout their life cycle. Although the origin of the profile variations is still under debate, one posited explanation is the varying importance of aliphatics versus aromatics in the carrier molecules.

We present the 5-12 micron spectra of sixty-three astronomical sources exhibiting PAH emission bands observed by ISO/SWS, Spitzer/IRS, and SOFIA/FORCAST. We aim to test this hypothesis by quantifying the aliphatic emission and identifying relationships between the aliphatic and aromatic emission features. We find that the presence of aliphatic features depends on PAH class, with aliphatic features detected in all class D sources, approximately half of the class B sources, and no class C sources present in our sample. We observe spectral variation of these aliphatic features in peak position and intensity. The peak position of the 6.9 micron feature varies continuously between 6.8 and 6.95 micron, with the variation being more pronounced in class B sources than in class D sources. In addition, the 6.9 micron feature is strongest in class D sources, in some cases being stronger than the 6.2 micron feature. Finally, our investigation of possible correlations between aliphatic and aromatic emission features only reveals a correlation between i) the two aliphatic bands, and ii) the aliphatic features and the 11.2 micron PAH band. We discuss these results within the framework of the varying aliphatic to aromatic ratio as the origin of the band profile variations.

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Primary author: Dr JENSSEN, Pernille (Aarhus University)

Co-authors: SHANNON, Matthew (NASA/Universities Space Research Association); Prof. PEETERS, Els (University of Western Ontario & SETI Institute); Dr STOCK, David J. (Department of Physics and Astronomy, University of Western Ontario, London, ON, N6A 3K7, Canada)

Presenter: Prof. PEETERS, Els (University of Western Ontario & SETI Institute)

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