Processing of hydrocarbon dust in a wide range of interstellar environments in nearby galaxies revealed by AKARI near-IR spectroscopy

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Hydrocarbon dust is one of the dominant components of interstellar dust, which mainly consists of polycyclic aromatic hydrocarbons and aliphatic hydrocarbons. While hydrocarbon dust is thought to be processed in interstellar radiation fields or shocks, detailed processing mechanisms are not completely understood yet; there are few statistical studies on the relationships between the aromatic and aliphatic components for a large number of objects with different interstellar environments.

Based on the luminosities of the aromatic hydrocarbon feature at 3.3 μm ($L_{\rm aromatic}$) and the aliphatic hydrocarbon feature at 3.4–3.6 μm ($L_{\rm aliphatic}$) estimated with the AKARI near-infrared (IR) 2.5–5 μm spectra, we have studied the relationships between $L_{\rm aromatic}$ and $L_{\rm aliphatic}$ for 299 nearby galaxies at redshifts lower than 0.3. The sample includes 138 star-forming galaxies at redshifts $0.01 < z < 0.3$, which are point-like sources with the AKARI resolution. The other 161 galaxies are very nearby ones at redshifts $z < 0.01$, most of which are spatially-resolved sources, with 961 spectra in total. As a reference sample, we also analyzed AKARI near-IR spectra of star-forming regions in our Galaxy, and obtained $L_{\rm aromatic}$ and $L_{\rm aliphatic}$ from 31 regions with 232 spectra in total.

As a result, $L_{\rm aliphatic}/L_{\rm aromatic}$ shows wide variations among the 299 sample galaxies. Overall, our sample galaxies systematically possess higher $L_{\rm aliphatic}/L_{\rm aromatic}$ than the star-forming regions in our Galaxy. Several spectra show unusually high $L_{\rm aliphatic}/L_{\rm aromatic}$ (> 1). On the other hand, for the IR-luminous galaxies, we find that galaxies with higher IR luminosities tend to exhibit lower $L_{\rm aliphatic}/L_{\rm aromatic}$. We also find that the galaxies with low $L_{\rm aliphatic}/L_{\rm aromatic}$ are dominated by merger galaxies.

Our results suggest that aliphatic hydrocarbon is highly processed by strong radiation fields and/or shocks due to galaxy mergers, while the degree of the processing of hydrocarbon dust may be significantly different from galaxy to galaxy. In this presentation, we discuss the causes of the variations in the processing of hydrocarbon dust for our sample galaxies, focusing on $L_{\rm aliphatic}/L_{\rm aromatic}$ in different interstellar environments.