A systematic study on the processing of hydrocarbon dust in various types of galaxies with AKARI and JWST

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Interstellar polycyclic aromatic hydrocarbon (PAH), or in more general, hydrocarbon dust which contains aromatic and aliphatic components, is known to exhibit numerous outstanding spectral band features in the near- to mid-infrared (IR) wavelength range. For example, Spitzer mid-IR spectroscopy has shown a variety of the PAH emission features for various types of galaxies, which reflects significant changes in the properties of PAHs, such as an ionization state and a size distribution. AKARI near-IR spectroscopy has revealed significant variations in the ratio of the aromatic to the aliphatic hydrocarbon spectral feature in galaxies, indicating structural changes of carbonaceous grains under the harsh interstellar environments. Currently, JWST provides us with detailed spatial distributions of their near- to mid-IR spectral features within a galaxy.

In this presentation, we first review the results of our systematic study with AKARI on the spectral properties of the hydrocarbon dust features at wavelengths of 3.3 to 3.6 microns for about 700 nearby galaxies. Our sample includes not only star-forming galaxies but also active galactic nuclei (AGNs) and even quiescent galaxies such as elliptical galaxies. We find that the flux ratios of the aliphatic to aromatic hydrocarbon feature vary widely from galaxy to galaxy. The results also reveal significant variations in the shape of the aliphatic feature profile and the center wavelength of the aromatic feature. Next, in addition to the AKARI overall results, we present the latest results of our spatially-resolved study with JWST on the aromatic and aliphatic hydrocarbon features for the interacting M51 and the early-type galaxy NGC1052, both of which are found to reveal spatial variations in the parameters characterizing the hydrocarbon dust feature profile.

Based upon those results, we suggest that hydrocarbon dust grains are being processed in various forms under the interstellar environments through photo-dissociation with the intense UV radiation fields associated with massive star formation activity in galaxies or shattering of large carbonaceous grains via mechanical shocks due to AGN outflows or galaxy interactions. In this presentation, combining the AKARI overall results on a large galaxy sample with the JWST detailed results on individual galaxies, we propose a general picture on the processing and evolution of hydrocarbon dust in galaxies, which can consistently explain our observational results with AKARI and JWST.