ALMA observations of peculiar embedded icy objects found by the infrared satellite AKARI

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Two peculiar embedded icy objects were found by the infrared satellite AKARI in the Galactic plane direction (Onaka et al. 2021, ApJ, 916, 75). Both objects show deep ice absorption features that are often seen in embedded young stellar objects (YSOs) or background stars sitting behind dense clouds, however, they are located neither in known star-forming regions nor in known dense clouds. Their infrared SEDs show a peak around 5 micron, which are incompatible with existing SED models of embedded YSOs. If they are truly YSOs, similar objects should have eluded past photometric surveys, which would require a revision of our view of the distribution of YSOs in our Galaxy. If they are background stars, there must be dense and very compact starless clouds in the line-of-sight, which have eluded past dense cloud surveys, or ice species may grow in unknown processes in tenuous clouds. Either case will make a significant impact on our understanding of the ice chemistry and/or star-formation process in our Galaxy.

To reveal their nature, we recently carried out submillimeter observations with ALMA (12m+ACA). Very compact emission of CO(3-2) and SiO(8-7) are detected at the positions of two icy objects. The observed large integrated intensity ratios of SiO(8-7)/CO(3-2) (~0.3-0.4), as well as their broad line widths (8-15 km/s), imply the contribution from shocked gas. Although a large dust extinction (Av ~80-120 mag) is expected from their deep dust/ice absorption bands, no dust continuum emission is detected, which would suggest a large beam dilution effect due to the compact size of the sources. Their systemic velocities are clearly separated from the surrounding CO clouds, suggesting that they are isolated.

These characteristics of the SEDs, the presence of deep dust/ice absorption features, and compact SiO-dominated broad molecular line emission, cannot easily be accounted for by standard YSO models. They may be explained as isolated, shock-dominated, edge-on disk sources without thick envelope, but detailed modeling is necessary. I will discuss possible nature of those icy objects.