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Warm Debris Disks Probed by Mid-Infrared Observations

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Some main-sequence stars are known to have dust disks around them, which should be composed of second-generation dust grains replenished during the main-sequence phase, rather than primordial dust from protoplanetary disks. These second-generation dust grains are thought to have originated in collisions of planetesimals or during the destruction of cometary objects, giving the reason circumstellar dust disks around main-sequence stars are named ”debris disks.” Debris disks are expected to be related to the stability of minor bodies and, potentially, to the presence of planets around stars. Debris disks are identified from the spectral energy distributions of stars that show an excess over their expected photospheric emission at infrared wavelengths, since circumstellar dust grains absorb the stellar light and re-emit mainly in the IR region. After the discovery of the first sample of debris disk, Vega, more than 100 others have been identified from the IRAS catalogue. Most of the known debris disks only show excess far-infrared emission. This excess comes from the thermal emission of dust grains with low temperatures, and is an analogue of Kuiper belt objects in the solar system. On the other hand, little is known to date about the warm debris disk material located close to the star, which should be an analogue of the asteroid belt in the solar system. Warm dust grains in the inner region of debris disks should have a more direct link to the formation of terrestrial planets than the low-temperature dust that has been previously studied.

To discover new warm debris disk candidates that show large 18 micron excess and estimate the fraction of stars with excess, we searched for point sources detected in the AKARI/IRC All-Sky Survey, which show a positional match with A-M dwarf stars in the Tycho-2 Spectral Type Catalogue and exhibit excess emission at 18 micron compared to expected photospheric level. In this presentation, we report initial results of the survey of warm debris disks around main-sequence stars based on the AKARI/IRC All-Sky Survey.

We also report the discovery of an intriguing debris disk toward the F3V star HD 15407A in which an extremely large amount of warm fine dust is detected. The dust temperature is derived as ˜500-600 K and the location of the debris dust is estimated as 0.6-1.0 AU from the central star, a terrestrial planet region. The luminosity of the debris disk is ˜0.5% of the stellar luminosity, which is much larger than those predicted by steady-state models of the debris disk produced by planetesimal collisions. The mid-infrared spectrum obtained by Spitzer indicates the presence of abundant micron-sized silica dust, suggesting that the dust comes from the surface layer of differentiated large rocky bodies.

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