Z302a Revealing Habitable Planet Formation via High-Resolution Infrared Observation

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Observation of planet formation events around temperatures of $\approx 300\,\mathrm{K}$ is necessary to reveal the origin of Earth-like habitable planets, which is allowed by mid-infrared observations with milliarcsecond-scale spacial resolution. In the late stage of terrestrial planet formation, Earth-like planets are believed to be formed from collisions among Mars sized protoplanets due to a long-term orbital instability in several 10Myrs. This formation scenario is consistent with the formation ages of Earth and Mars inffered from the Hf-W chronometer. Such collisions between protoplanets produce a large amount of fragments, whose thermal emission is bright enough for observation (Genda et al. 2015). Such a fragment cloud forms characteristic small structures with time evolution. Therefore, 0.1 au-scale observations reveal collisional events in habitable planet formation. In addition, high-resolution observations are effective for planetary systems after completion of planet formation. In the solar system, asteroidal collisions and/or cometary activities form dust grains, which drift inward via the solar radiation to be zodiacal dust. The clumps of drifting zodiacal dust are formed around planets due to their gravities, as seen around Earth (Ueda et al. 2017). Observations of such exo-zodi clumps may reveal hidden faint planets as well as the "activity" of collisions and comets in the planetary systems. High-resolution and high-contrast ($< 10^{-5}$) observations are required for the detections of exo-zodi clumps, which will be achieved by future IR-interferometers, such as Large Interferometer for Exoplanets (LIFE).