STUDY OF EXOPLANET WITH SPICA

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SPICA: SPICA is the next-generation, space infrared observatory, following in the footsteps of IRAS,ISO, Spitzer, AKARI and Herschel. With its 3.2-meter telescope cryogenically cooled to 6 Kelvin, SPICA provides an extremely low background level environment. With its instrument suite, designed with state-of-the art detectors to fully exploit this low background, SPICA will provide high spatial resolution and unprecedented sensitivity in the mid- and far-infrared. These unique capabilities will bridge the gap between ALMA/large submm ground telescopes and JWST/large ground opt.-IR telescopes. Thus astronomers will be allowed to address key problems in present-day astronomy in many research areas, ranging from the formation of planets to the large scale star-formation history of the Universe. SPICA is proposed as a Japanese-led mission, with extensive international collaboration. The satellite is targeted for launch in the 2020s with a nominal mission lifetime of three years.

The SPICA Coronagraph Instrument (SCI): The SPICA Coronagraph Instrument (SCI) is proposed to SPICA for the purpose of studying small-scale structures surrounding bright stars and galactic nuclei, which specifically include exoplanets (not only detection but also characterization of the atmosphere), proto-planetary and debris disks, and dusty tori of active galactic nuclei. High contrast images of the SCI are produced by binary pupil-mask coronagraphs together with the image subtraction technique. The SCI is designed to have both functions of imaging (1' x 1' field of view) and spectroscopic capability (R=200). The SCI possesses the capability of low-background spectroscopic coronagraphy over the continuous wavelength range of 4 - 28 micron. These specifications make the SCI a unique instrument in functions of the high dynamicrange observation in the 2020s, including instruments of JWST and TMT.

Study of Exoplanet with the SCI: One of important science objectives is Planetary Formation Process Revealed by the Thermal History, including examination of the core-accretion model and the disk instability model for the formation of planetary systems. These models indicate different temperature of the exoplanet especially young phase of the planets. So, detail measurements of temperature of exoplanet atmosphere is important. The SCI is designed for high-dynamic range spectroscopy and imaging in the 4 to 28 microns wavelength range. The spectral features of atmospheric molecules are crucial indicators of the planetary temperature. Since there are several important molecular absorption lines within the wavelength coverage of the SCI, (CO (4.7 μm), CH_4 (6.5 μm, 7.7 μm), NH_3 (6.1 μm, 10.5 μm), and H_2O (6.2 μm)) the atmospheric temperature can be determined precisely by spectroscopic studies of the planetary atmosphere. CO and N_2 are stable at temperatures higher than 1500 K. As the temperature decreases, CO and N_2 react with H_2 to form CH_4 and NH_3. As a result, CH_4 and NH_3 become the dominant carbon- and nitrogen-bearing species at low temperatures, respectively. At a total gas pressure of 1 atmosphere, CH_4 and NH_3 mainly form at temperatures below 1000 K and 700 K, respectively. In addition, the mixing fraction of H_2O increases by releasing the oxygen tied up in CO. Thus, while CO is an indicator of high-temperature objects, CH_4, NH_3, and H_2O are indicators of low-temperature objects. Thus, combination of SPICA and the SCI is essentially useful for this study. Other science objectives of the SCI based on wide mid-infrared spectrum of the atmosphere of exoplanets are also important, of which studies will be possible thanks to unique capability of SPICA and the SCI.