SPICA Mid-Infrared Instrument (SMI)


SPICA mid-infrared instrument (SMI) is one of the two focal-plane science instruments planned for SPICA. SMI covers a wavelength range of 12–36 μm with four channels: low-resolution spectroscopy (LR; 17–36 μm), mid-resolution spectroscopy (MR; 18–36 μm), high-resolution spectroscopy (HR; 12–18 μm), and broad-band camera (CAM) at 34 μm, slit viewer for LR.

**SMI specifications**

- **LR-CAM**: prism (4 slits, 10' long, R~100), with a 10’x12’ slit viewer, high-speed dust-band mapping.
- **MR**: Echelle grating with a cross-dispenser (1’ long, R~2000), combined with a beam-steering mirror, high-sensitivity multi-purpose spectral mapping.
- **HR**: CdZnTe immersion grating (R~30000), realizing compact optics. High-resolution molecular-gas spectroscopy.

**Optical & Mechanical design**

Advantages of SMI over JWST, ground-based facilities

- (Left) Survey speed of LR, time to reach 10^{-12} W/m² for a 10’x10’ area.
- (Right) Line sensitivity of HR, compared to ground-based facilities.

The spectral resolution of HR, compared to JWST/MIRI (R~3000), is important to mitigate the line blending.

**Demonstration of SMI mapping capability**

**SMI key sciences**

- **LR-CAM** surveys will detect organic matters (PAH) and minerals in high-z galaxies as well as in planet-forming disks, while **MR** will characterize them in detail. **HR** will characterize molecular gases and resolve their velocities in planet-forming disks.

**Evolution of galaxies**

- *LR-z dist. of detectable galaxies (0.2 deg) with LR, 1 deg to 300 deg*: wide-area spectroscopic survey with LR
- *LR-z dist. of detectable PAH galaxies (10 deg) with LR*: diagnosis of PAH galaxies, AGNs & follow-ups for MR and SAFARI
- *Characterization of star-forming galaxies & AGNs in high-z Universe Imaging survey with CAM*: star-formation history up to z = 7

**Protoplanetary/debris disks to our Solar system**

- **Determining snow-line location** (Kaneda et al. 2017)
- **Detecting exo-zodiagal clouds** (Kaneda et al. 2017)

**Critical technologies**

- **Immersion Grating**: machining & material selection established, reflection coating under development. Cryogenic performance will be measured.
- **Detector**: thermal design for annealing tested in CC-CTP. Current spec. of Si:Sb confirmed. Collaboration with Taiwan (ASIIIA) is re-started.

**Current status**

- **3 SMI white papers** (Gruppioni et al. 2017, Kaneda et al. 2017, Nakagawa et al. in prep.)
- **Re-analysis of the SMI/LR-CAM optics** to make space for SAFARI, to install a cold shutter.
- **Observation and calibration strategies**.
- **Detector-related activity, Developing immersion grating.**