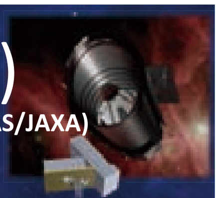
P-098

SPICA Mid-Infrared Instrument (SMI)



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and the SMI consortium

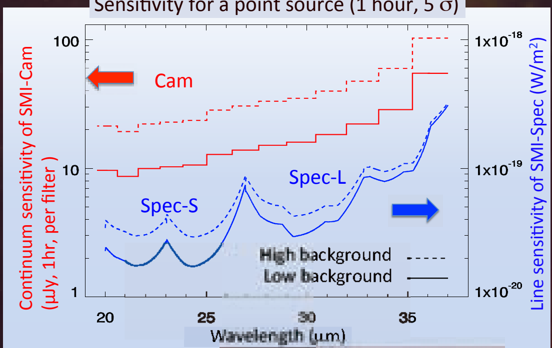
Abstract

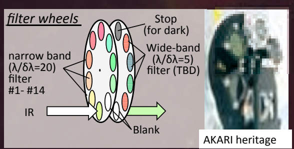
SPICA Mid-infrared Instrument (SMI) is a Japanese focal-plane instrument, slimmed and refined for new SPICA, which focuses on longer wavelengths and higher mapping efficiency than the previous instrument MCS. SMI is designed to cover the wavelength range of 20–37 µm (+17-20 µm: optional) with one imaging channel (SMI-Cam) and two spectroscopic channels (SMI-Spec-S/L). In the framework of the SPICA key science programs, SMI will characterize galaxy and material evolutions from the high-redshift to local universe by means of dust bands, such as those of PAHs and silicate grains.

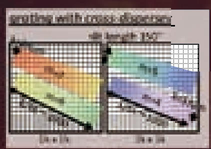
SMI specifications

SMI uses 3 Si 1kx1k array detectors, 1 Si:Sb for Cam and 1 Si:Sb + 1 Si:As for Spec. SMI-Cam has a wide FoV and adopts a 14 narrow-band filter changer system, which enables R=20 SED survey detecting dust bands with high imaging efficiency & quality. SMI-Spec has a long slit, adopts Echelle grating with cross-disperser, and performs R=1000 spectral mapping with a Spitzer/IRS-type scan, which enables detailed diagnostics using gas lines & dust bands with high sensitivity.

Sensitivity for a point source (1 hour, 5 σ)

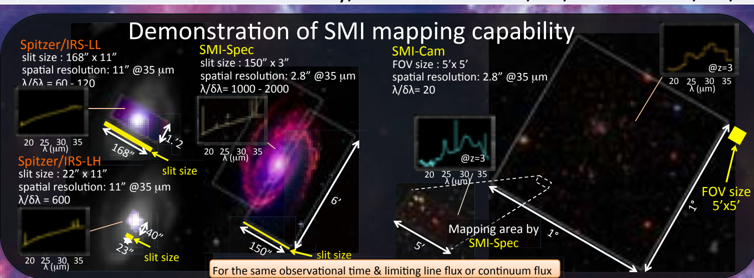






		Cam	Spec-S	Spec-L
	Wavelength	20-37 µm	20 – 27 µm (17-20 µm optional)	27-37 µm
	Spectral resolution	20 14-filter changer	1000-2000 (point source) 1000 (diffuse)	
	Field of View	5′ x 5′	slit: 150″ x 3″ (common)	
	Beam size	1.″4 – 2.″6		
	Pixel scale	0.″5 x 0.″5	0.″5 x 0.″7	
Point source	Cont. sensitivity (1 hr, 5 σ)	9 – 50 µJy (per filter)	0.1 – 0.5 mJy	0.2 – 1 mJy
Point source	Line sensitivity (1 hr, 5 σ)	(6 – 15) x 10^{-20} W/m² (no continuum assumed)	(2 – 7) x 10^{-20} W/m²	(3 – 10) x 10^{-20} W/m²
Point source	Survey speed (reaching flux)	~7 arcmin²/hr (40 µJy) SED survey (14 filters)	~4 arcmin²/hr (2 x 10^{-19} W/m²)	~2 arcmin²/hr (2 x 10^{-19} W/m²)
Point source	Saturation limit	~ 1 Jy	~ 100 Jy	~ 400 Jy
Diffuse	Sensitivity (1 hr, 5 σ, per 3″ x3″)	Continuum 0.2 – 1 MJy/sr (per filter)	Line (TBC) (1 – 4) x 10^{-9} W/m²/sr	(2 – 5) x 10^{-9} W/m²/sr
Diffuse	Saturation limit	~ 10^4 MJy/sr	~ 10^{-4} W/m²/sr	~ 10^{-4} W/m²/sr

Demonstration of SMI mapping capability



SMI key sciences

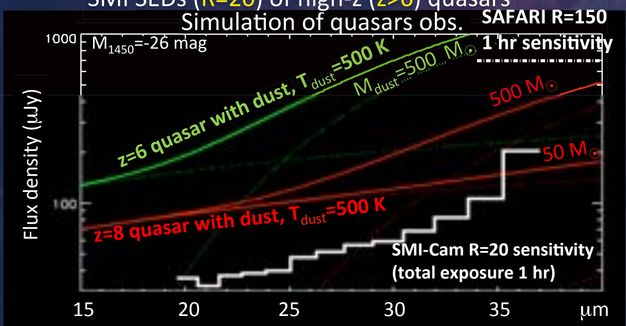
The SMI R=20 SED survey will find dust including PAHs and silicates in many high-z objects, while the R=1000 spectroscopy will determine the compositions of silicates and the conditions of PAHs. The following two are examples among SMI key sciences.

Dusty torus formation and evolution of quasars

Dusty torus formation by probing hot dust properties in quasars - Evolution sequence from dust free quasars at z=6 (Jiang+ 10) to typical quasars with hot dusty torus

SMI SEDs (R=20) of high-z (z>6) quasars

Simulation of quasars obs.

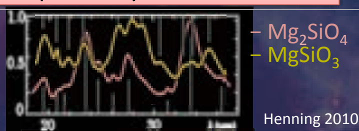


- z=8 quasars detectable even if M_{dust} is small.
- Determination of hot dust properties in high-z quasars
  Revealing the history of dust accretion with M_{dust} & T_{dust}
  Detection of the first dusty torus
- The number of targets will increase much by 2025.
  >100 @ z>6 quasars (M_{1450}<-26) by HSC, LSST, ...

Evolution of minerals in planet-forming disks

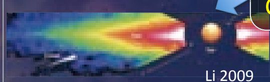
Planet-formation scenario through studies of evolution of various minerals in proto-planetary and debris disks.

SMI spectra (λ=20–37µm, R=1000) of silicates in disks at various stages



Proto-planetary disks

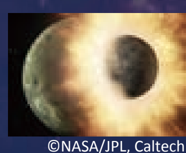
- Thermal history
- Radial mixing of materials



Temperature
Mass
Crystallinity
Composition

Debris disks

- Giant impact, LHB



- Wavelength coverage complementary to JWST
  ⇒ detailed compositions (e.g. Fe/Mg ratio)
- Spitzer/IRS/LH-like high R with sensitivity better than LL
  ⇒ Increase the number of well characterized sample (from dozen to hundreds) ⇒ Comprehensive study
- Spatially resolved observations for A-type stars
  (3″ corresponds to 60 AU@20 pc)