SPICA搭載中間赤外線観測装置
Mid-infrared Camera and Spectrometer (MCS) on board SPICA

SPACE INFRARED TELESCOPE FOR COSMOLOGY AND ASTROPHYSICS

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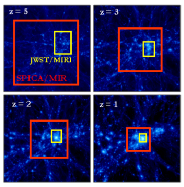


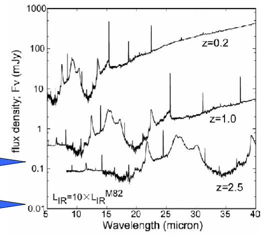
The proposed 5' x 5' FoV of WFC (red squares) on top of the simulation of cluster formation by Yahagi et al. The JWST/MIRI FoV (yellow rectangle) is also shown as a comparison.

General Outline

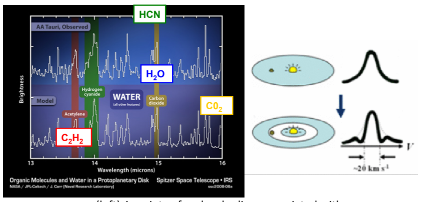
Wide-field Imager & Spectrograph at 5-38µm
Detectors:
- Si:As 2Kx2K @5-6K / Si:Sb 1Kx1K @ ~3K

Channels:
- Wide-field Camera (WFC)
- Medium-Resolution Spectrometer (MRS)
- High-Resolution Spectrometer (HRS)
- Low-Resolution Spectrometer (LRS)

Observing Mode:
- Imaging/spectroscopy with micro-scan/step-scan



Simulated spectra of galaxies at z=0.2, 1.0 and 2.5 assuming that their spectral shape is the same as that of M82 but their IR luminosities are 10 times of M82.



(left) A variety of molecular lines associated with a protoplanetary disk. Adapted from Spitzer Press Release.
(right) Schematic view of how the disk clearing due to a proto-Jupiter would change the emission line profile.

Specifications:

Specifications of instruments and detector arrays are summarized in the following tables.

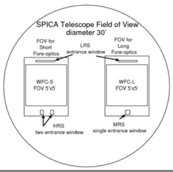
Table 1: Specifications of instruments

	Imaging		Spectroscopy					
Instrument	WFC		LRS		MRS		HRS	
Channel	S	L	S	L	S	L	S	L
Array format	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:Sb (1k x 1k)	Si:As (2k x 2k)	Si:As (2k x 2k)
Wavelength coverage (μm)	5-25	20-38	5-26	20-38 (option 25-48)	10-20	19.5-36.1	4-8	12-18
Filter bands	5-25 μm, R=5	20-38, R=10						
Spectral resolution (λ/Δλ)			50-100	50-100	1460 @ 13 μm	680 @ 27.8 μm	30,000	20,000-30,000
FOV size	5' x 5'	5' x 5'			12" x 6"	12" x 12".5		
Slit length x width			2'.5 x 1".40	2'.5 x 2".66	12" x 1".2 (x 5 slices)	12" x 2".5 (x 5 slices)	3".5 x 0".72	6".0 x 1".2
Pixel scale ("/pix)	0".146/pix	0".293/pix	0".146/pix	0".293/pix	0".403/pix	0".485/pix	0".288/pix	0".48/pix
Main disperser			Prism	Grating or Prism	Grating	Grating	Immersion grating	immersion grating

Design

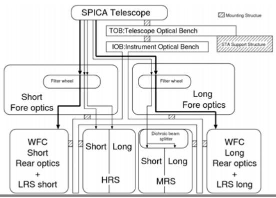
Field of View

MCS occupies tow entrance window at tel. focal plane

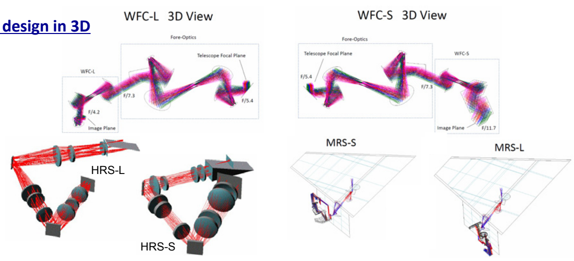


Architecture

WCS-S, LRS-S and HRS have a common fore-optics. WCS-L, LRS-L and MRS have another common fore-optics.



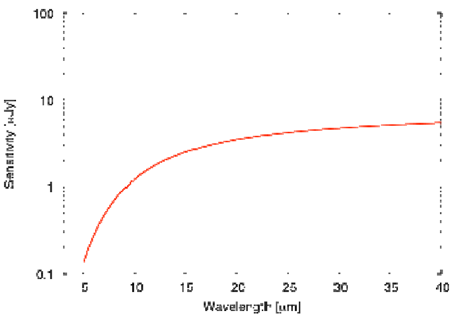
Optical design in 3D



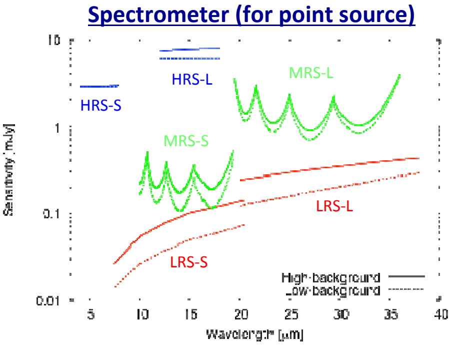
Sensitivity estimation (5σ, 1hr)

Estimated sensitivities are shown in the following figures.

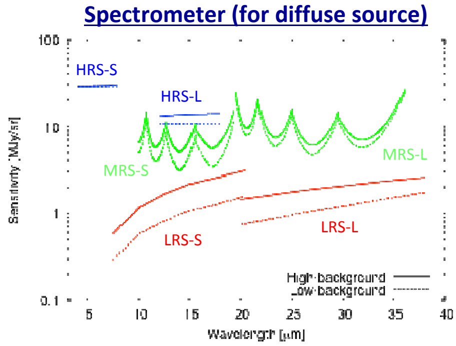
WFC (for point source, R=5)



Spectrometer (for point source)



Spectrometer (for diffuse source)



Assumptions: Following assumptions are used for sensitivity estimations.

Brightness of the background

The main brightness source is the zodiacal emission, which varies with the line of sight. Two cases, low- and high-background, are assumed (e.g., Leinert et al. 1998, Reach et al. 2003).

low (ecliptic latitude ~ 90°): 274K blackbody, 15.5MJy/sr @ 25 μm
high (ecliptic latitude ~ 0°): 268.5K blackbody, 80MJy/sr @ 25 μm

Other parameters

Telescope diameter: 3.0 m
Effective area of the telescope: π x (3.0/2)^2 x 0.875 m^2
Integration time of one frame: 600 sec.

Performances of arrays

	Si:As	Si:Ab
Format	2048 x 2048	1024 x 1024
Wavelength	1-26 μm	1-38 μm
Average quantum efficiency	> 40% (Goal > 80%)	> 50% (for 20-38 μm, incl. refl.)
Peak quantum efficiency	-	> 60% (for 20-38 μm, incl. refl.)
Assumed quantum efficiency	50% @ all wavelengths	50% @ all wavelengths
Readout noise*	20 e^-	100 e^-
Assumed readout noise	5 e^-	25 e^-
Dark current	< 0.5 e^-/s/pix < 0.2 e^-/s/pix (Goal)	< 2 e^-/s/pix for 1024 x 1024 area < 0.2 e^-/s/pix for 1024 x 900 area < 0.1 e^-/s/pix (Goal)
Assumed dark current	0.5 e^-/s/pix	2 e^-/s/pix
Pixel size	25 μm	18 μm

*Noise in CDS readout. The noise will be reduced up to 1/4 in Fowler-16 sampling.

For each instrument

HRS

HRS uses simple assumptions for the optical system.
optical efficiency (lens and immersion grating): 0.15
slit efficiency for a point source: 0.6 for HRS-S, 0.3 for HRS-L

LRS, MRS

LRS and MRS take into account wavelength dependencies of the optical and the slit.

WFC

WFC uses slightly different assumptions as; readout noise of 20e-, dark current of 1e-/s/pix, optical efficiency of 0.35 (including telescope), background of 216K blackbody with 18MJy/sr @ 25 μm.