The SPICA infrared space observatory – project status

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  - Next milestone; mission selection in 2019
SPICA’s science

M5; unveiling dusty matter in the universe
The SPICA ‘sweet spot’ – the dusty universe

A unique observatory
looking through the veils, enabling transformational science

What is so unique?

• A **COLD, big** mirror
  → **true background limited** Mid/Far-IR observing
    >2 orders of magnitude better raw sensitivity than Herschel

• ~20 to ~350 μm **inaccessible for any observatory**
  → the wavelength domain where **obscured matter** shines
    fill the blind spot between JWST and ALMA @ R~ few 1000
Science Objectives – mission design drivers

- What processes govern **star formation across cosmic time**
  - what starts it, controls it, and stops it?
  - What are the major physical processes in the most obscured regions of the universe?
  - How is this related to the enrichment of the universe with metals

- What is the **origin** and composition of the **first dust**, how does this relate to present day dust processing?

- What is the thermal and chemical **history** of the **building blocks of planets**?

- What is the role of magnetic fields in dust filaments?
The SPICA mission
the M5 configuration
SPICA – proposed to ESA/M5

- ESA-led mission
  with large JAXA contribution
- ‘PLANCK configuration’
  - Size - Φ4.5 m x 5.3 m
  - Mass - 3450 kg (wet, with margin)
  - V-grooves
- 2.5 meter telescope, < 8K
  - Warm launch
- 12 - 230 μm spectroscopy
  - MIR imaging spectroscopy – SMI
  - FIR spectroscopy – SAFARI/SPEC
  - FIR polarimetry – SAFARI/POL
- ‘standard’ Herschel/Planck SVM
- Japanese H3 launcher, L2 halo orbit
- 5 year goal lifetime
Who provides what

- Telescope (ESA)
- Payload Module
- Cryocooler
- Bus Module
- Launcher
- SPICA Data Center
- Focal Plane
- Instrument Assembly
- FIR Spectrometer (SAFARI)
- MIR Instrument (SMI)

Complexity in responsibilities and interfaces → challenging AIV program
Main challenge – <8K telescope thermal design

- Active cooling to 4K and 1.7K
  - Detector modules at 50mK with dedicated mK coolers (SAFARI)
- V-grooves – passive cooling to 40K
- Detachable support struts
The SPICA Instruments
The Far-IR instrument SAFARI

**SAFARI/SPEC - high sensitivity** grating spectrometer
- Basic R~300 mode → 1hr/5σ $-5-7 \times 10^{-20} \text{ W/m}^2$ (4.6 m$^2$)
  - Improves with better TES performance!
- Martin Puplett Interferometer to provide High-R mode
  - Backup: Fabry-Pérot Interferometer
- 4 bands *instantaneously* covering 35-230 micron
  ...limited imaging capability: 3 pixels on-sky

**SAFARI/POL - imager polarimeter**
- Polarization sensitive bolometers
  - 3 bands: 110, 220, 350 µm
- FPA architecture designed and tested
- Readout analogous to PACS system

*US/JPL contribution: LW/VLW grating modules*
The Mid-infrared Instrument SMI

- **SMI/LR-CAM** – large area low resolution surveyor
  - 17 – 36 µm, R = 50 – 120
  - 4 slits (10’ long) with prism
  - Detector: Si:Sb
  - Camera mode 10’x12’ FoV

- **SMI/MR** – medium resolution mapper
  - 18 – 36 µm, R = 1200 – 2300,
  - 1 slit (1’ long) with grating
  - Detector: Si:Sb

- **SMI/HR** – molecular physics/kinematics
  - 12 – 18 µm, R = 28,000
  - 1 slit (4” long) with immersion grating
  - Detector: Si:As
SPICA capabilities - spectral resolution

\[ \frac{\lambda}{\delta\lambda} (\delta v) \]

- 10000 (30 km s\(^{-1}\))
- 1000 (300 km s\(^{-1}\))
- 100 (3000 km s\(^{-1}\))

Wavelength

JWST

SMI/HR

SMI/MR

SMI/LR

Herschel

SAFARI

ALMA
SPICA sensitivity/speed – a **huge** leap forward

Raw sensitivity improvement >2 *orders* of magnitude

Instantaneous full spectra → huge step in efficiency
The programmatic context and the outlook
Governance and harvesting

- **International mission** → international oversight
- **SAFARI/consortium** has influence through representation at various levels
  - Instrument
  - SPICA system
  - SPICA executive board
  - Science advisory committee

- **Observing time**
  - Mission will be open for *all astronomers*
  - Guaranteed v.s. open time details TBD
  - Detailed implementation of e.g. ‘Key projects’ TBD
  - Time Allocation Committee
Mission Status

- Mission well defined
  - Spacecraft elements, responsibilities
  - Instrument complement ready to start phase-A

- Japan: SPICA passed ‘Mission Definition Review’
  - SPICA officially in ‘Pre-project’ phase (~phase A)
    - 2027/2028 H3 slot tentatively assigned to SPICA

- M5 proposal under evaluation
  - ESA-led mission (~550M€) with JAXA participation
    - JAXA *committed* to support at the ~300M$ level
  - European/Canadian/US instrument - SAFARI
  - Mission candidate selection: June/2017
    - Phase A/B1 under ESA-led study team
    - Mission final selection: 2019
    - Launch: 2028/2029
Summary

- **SPICA**: a mid-far infrared space observatory
  - 2.5 m diameter mirror, actively cooled to 8 K
  - \textit{unprecedented sensitivity} in \textit{mid/far IR}
    - ESA/JAXA project with PI-provided instruments
    - Open for astronomical community

- **SPICA focus**: spectroscopy of the obscured universe, straddling the gap between JWST and ALMA

- **SPICA is proposed as a candidate for ESA M5**
  - Candidate selection in June 2017, final selection Q4/2019
  - Launch \~2029

SPICA supporters/joiners?

register at [www.spica-mission.org](http://www.spica-mission.org)

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