SPICA Mission Overview

7-8 February 2012 @ Italian Workshop on SPICA

Hideo Matsuhara, Takao Nakagawa, &
Yasuhiro Kawakatsu (JAXA) for SPICA Team

Institute of Space & Astronautical Science
Japan Aerospace Exploration Agency

JAXA 宇宙航空研究開発機構 Japan Aerospace Exploration Agency

Our Scientific Goals

How did the Universe originate and what is it made of ?

Galaxy Formation and Evolution as revealed in the Infrared

The Cycling of Matter Between Stars, Galaxies and the Intergalactic Medium

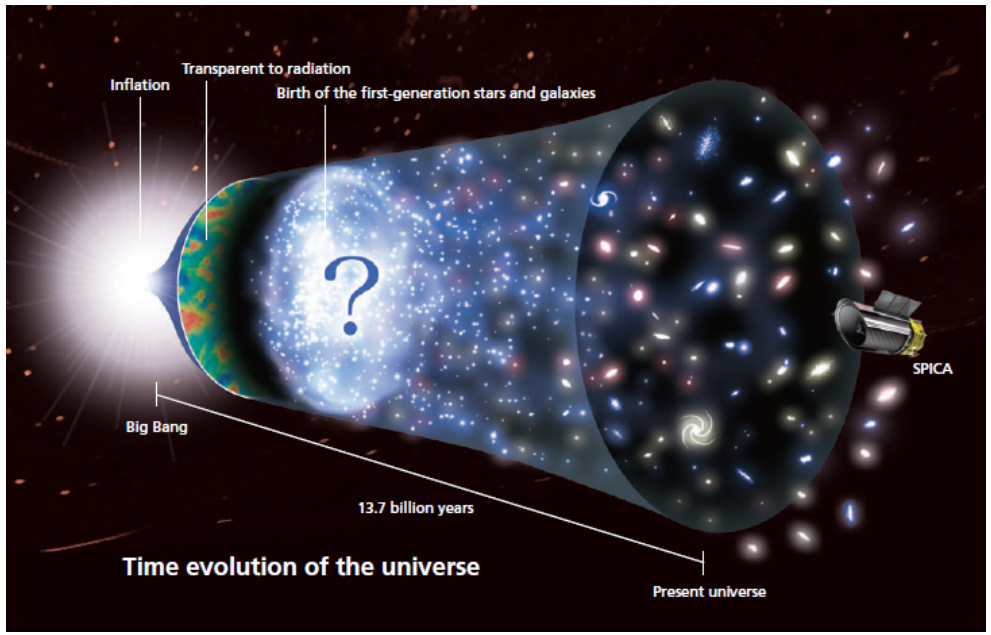
What are the conditions for stellar and planetary formation ?

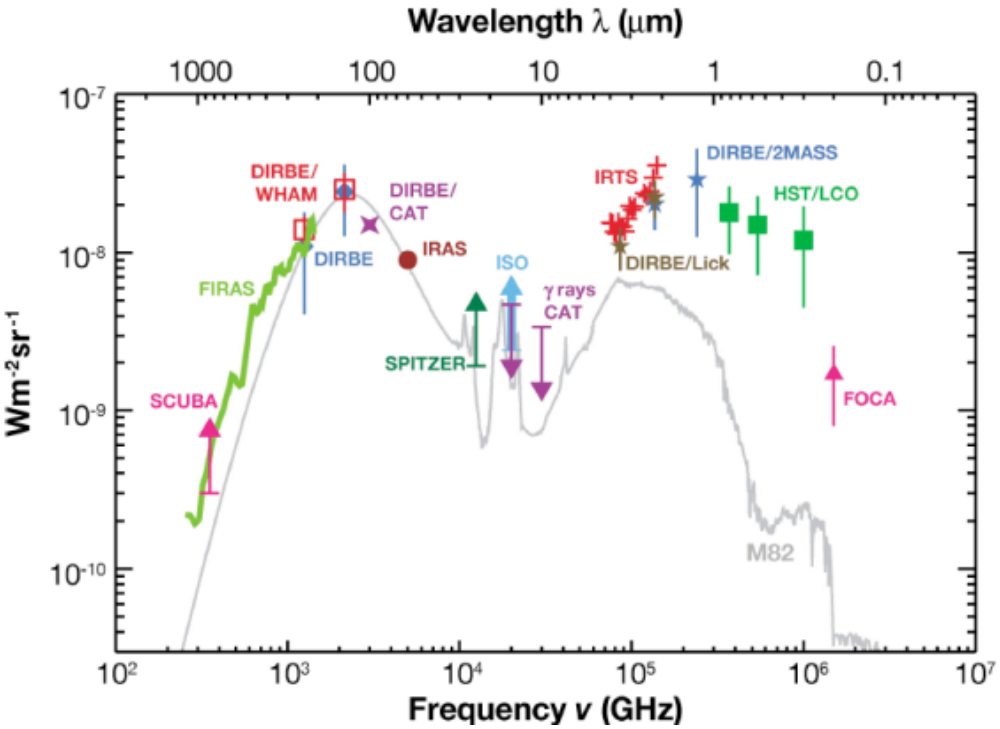
Evolution of planetary systems

Characterization of exoplanets

How did the Universe originate and what is it made of ?

- *Galaxy Formation and Evolution as revealed in the Infrared*

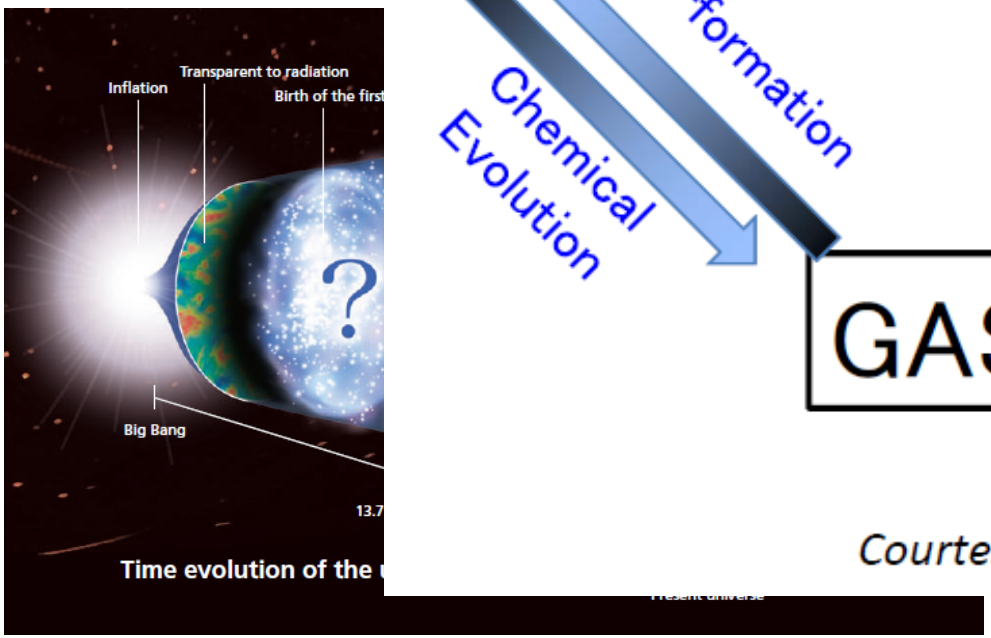




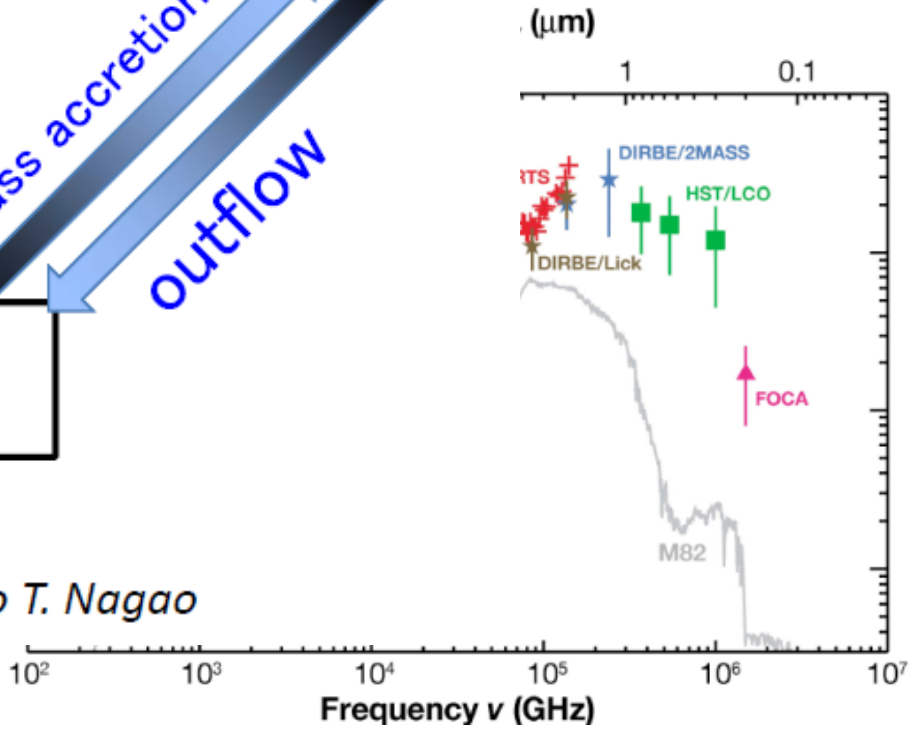
SPICA
Space Infrared Telescope for Cosmology and Astrophysics

How did the Universe originate and what is it made of ?

- *Gala*
  reve



Courtesy to T. Nagao



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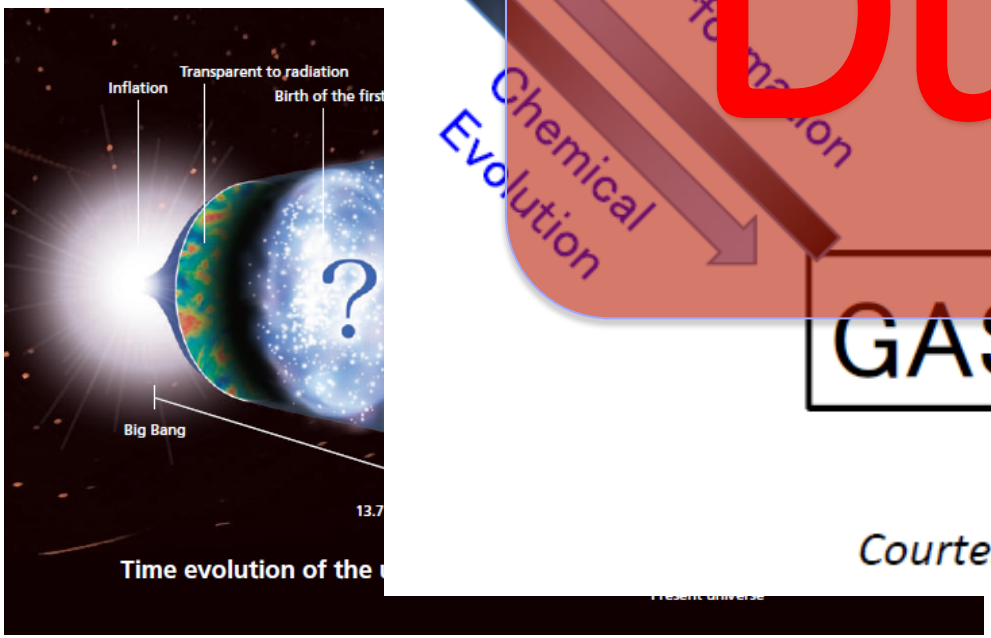

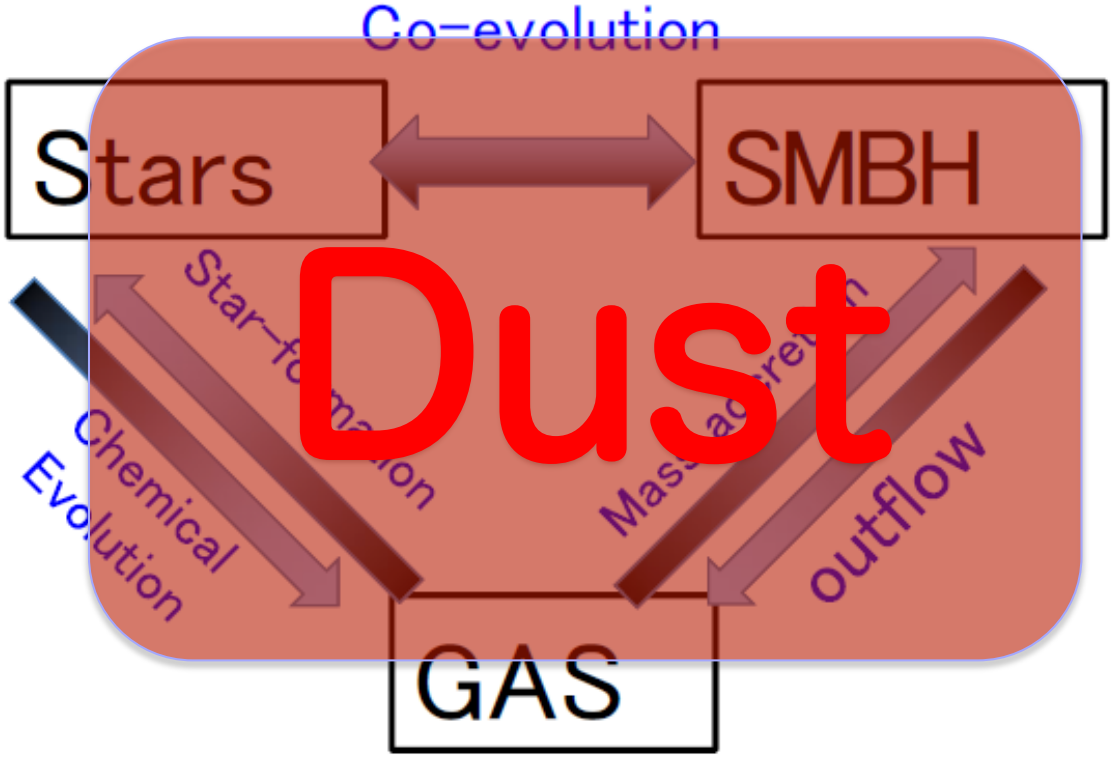

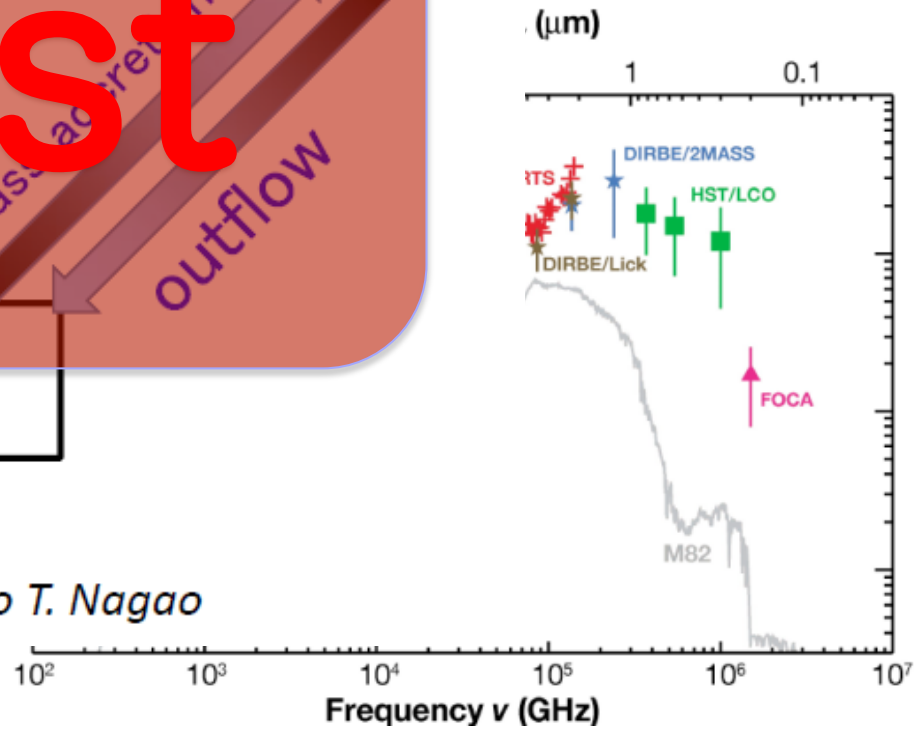

Courtesy to T. Nagao

→ **Hidden Universe to be revealed by FIR Observations**

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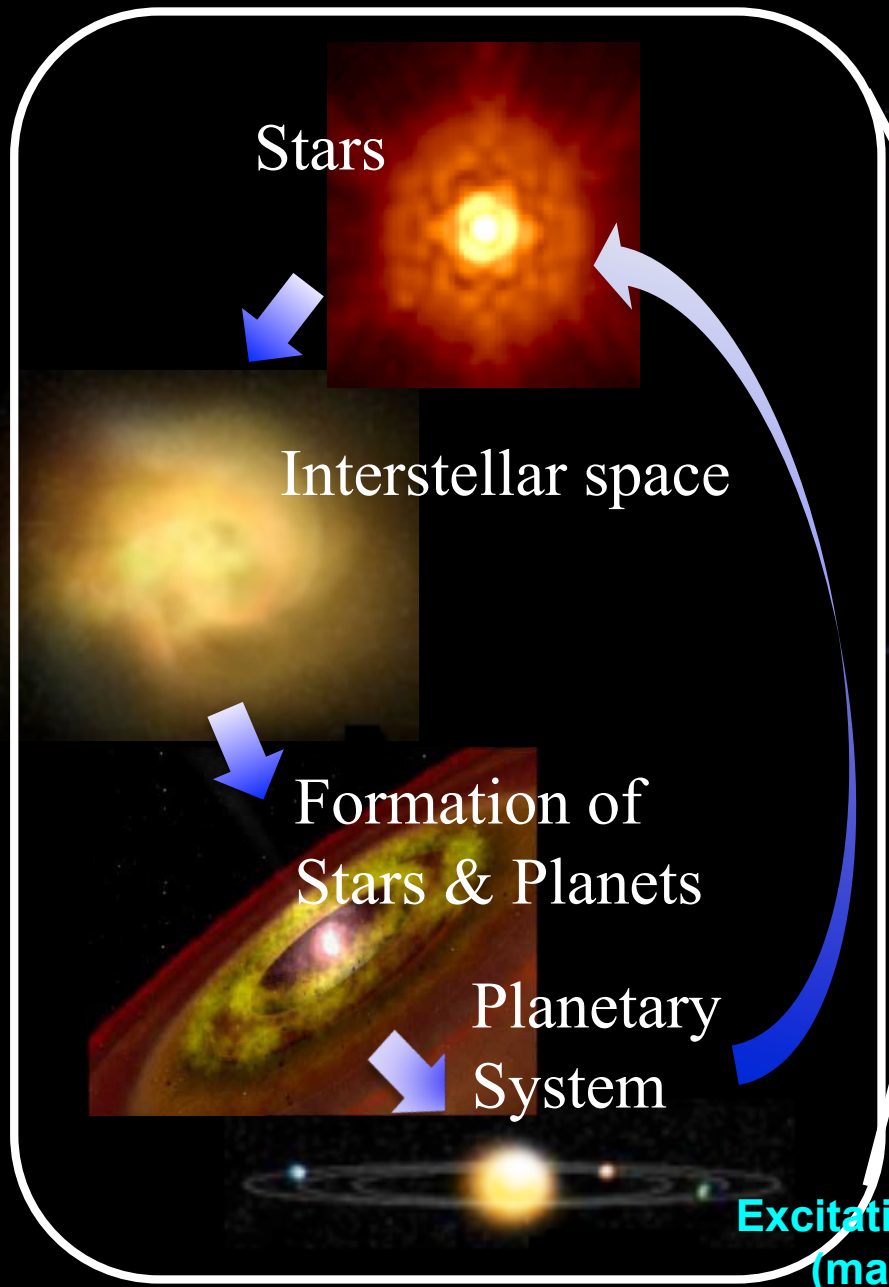
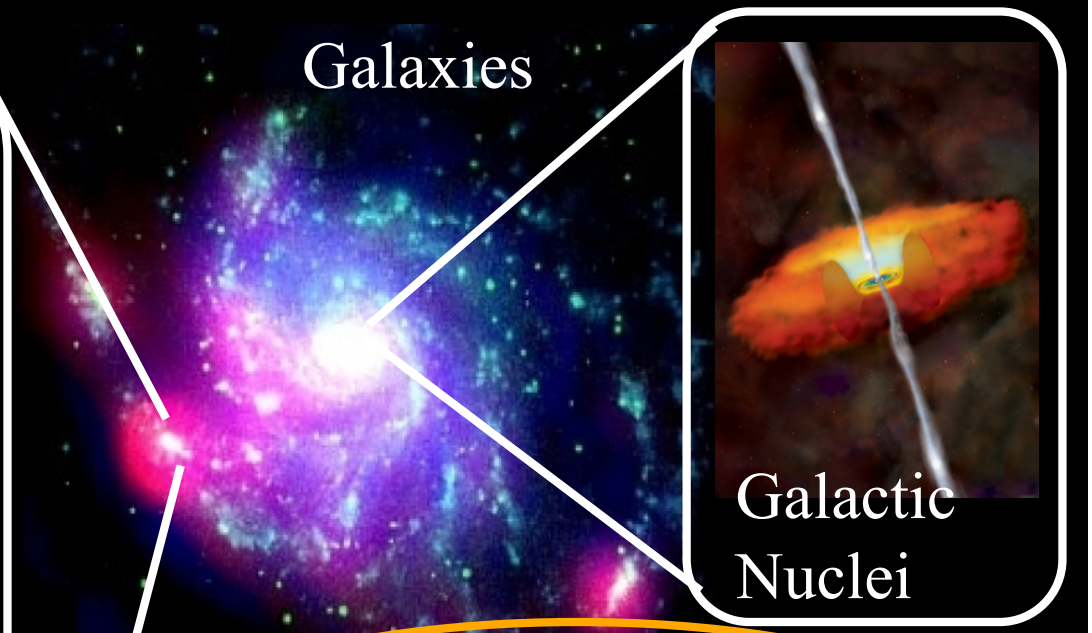
"Transmigration" & Evolution of Matter





Interstellar gas → Galaxies

⇓ MCS, SAFARI ⇓

Molecular Cloud Core → Galactic Center

⇓ ⇓

SCI

Disks (planets) → dust torus

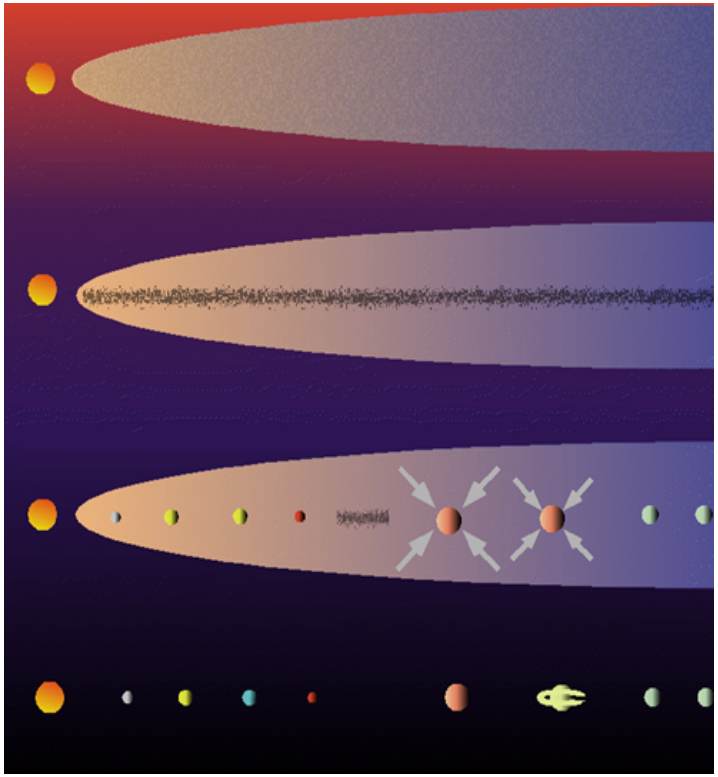
⇓ ⇓

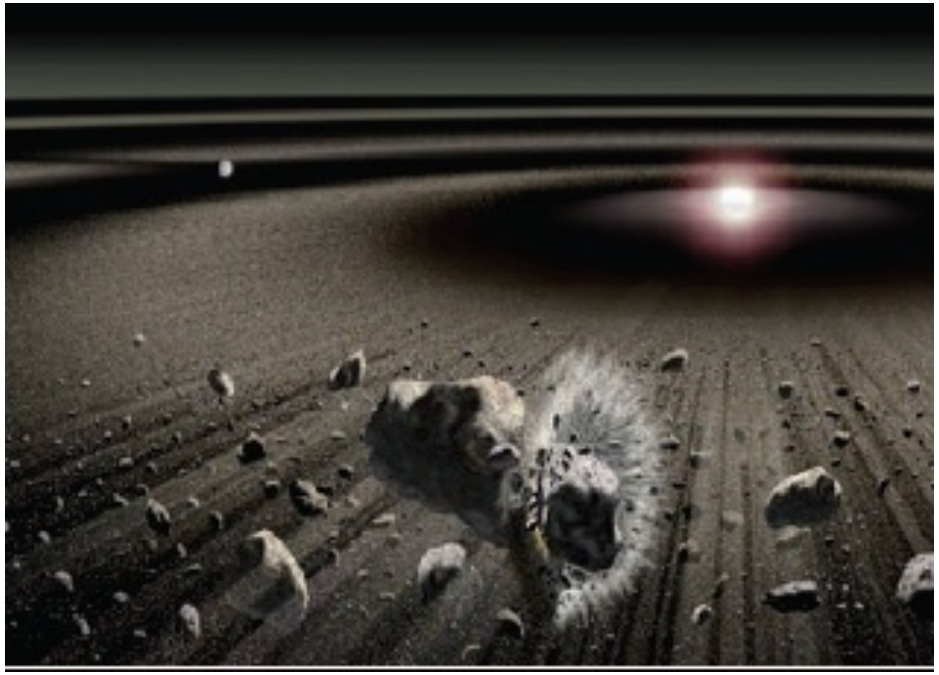
Excitation sources (masked by Coronagraph) → Stars → AGN

Courtesy to H. Kaneda

What are the conditions for stellar and planetary formation ?

- Evolution of planetary systems
- Characterization of exoplanets





→ **Mid- and Far-IR observations for gas and dust phases**

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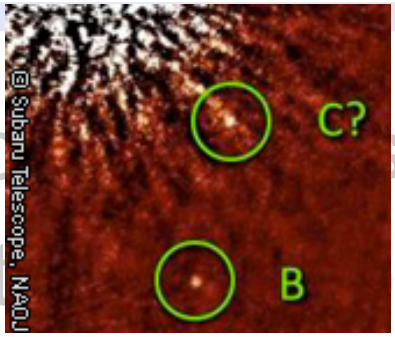
Key Targets

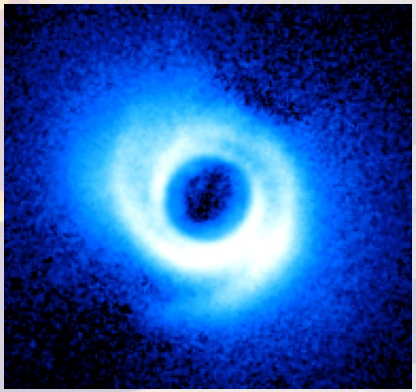
What are the conditions for stellar and planetary formation ?

- Evolution of p systems
- Characterizat planets

Exoplanets

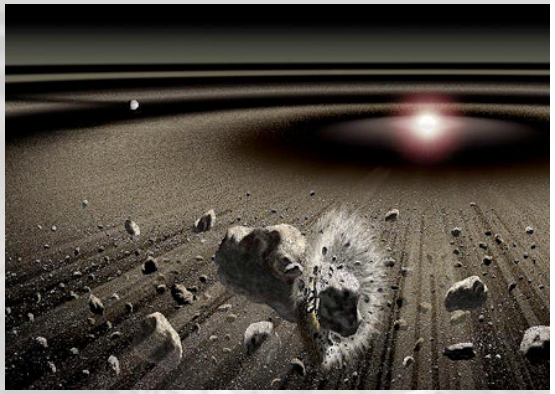


Proto-planetary Disk

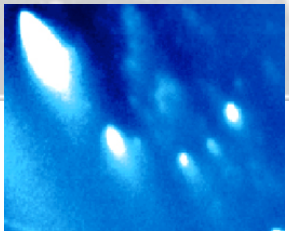


Evolution

Debri-Disk



Small bodies in Our Solar System (TNO, Comets)



Courtesy to M. Takami & Subaru/SEED team

SPICA
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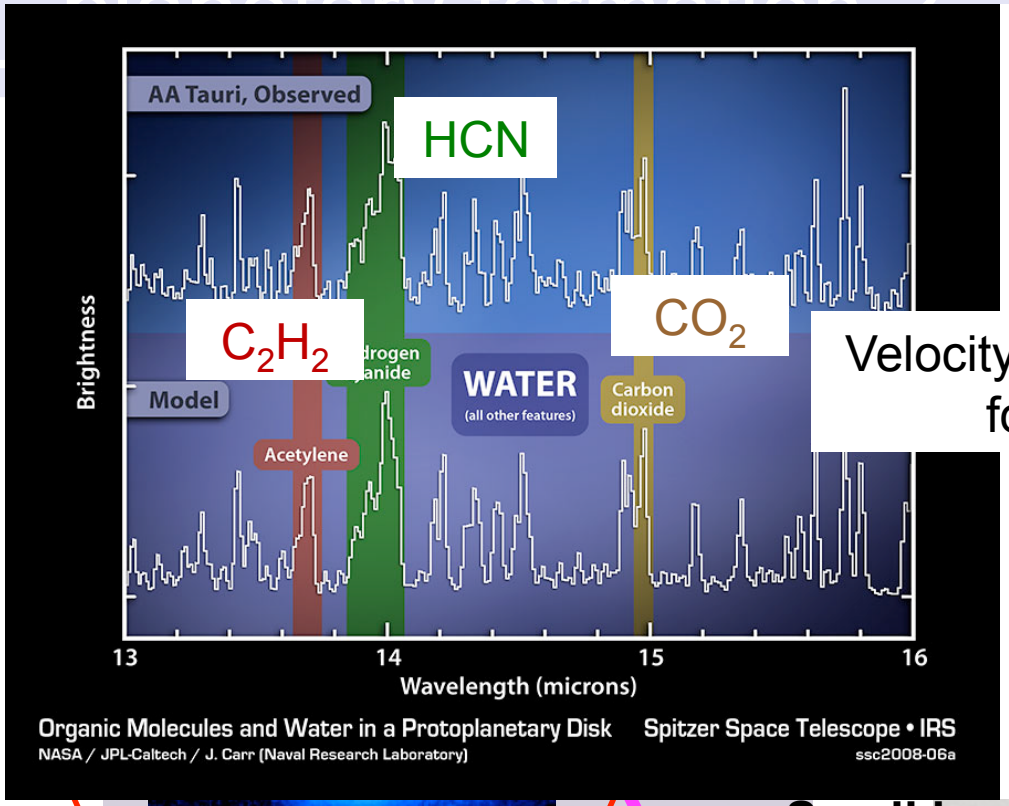
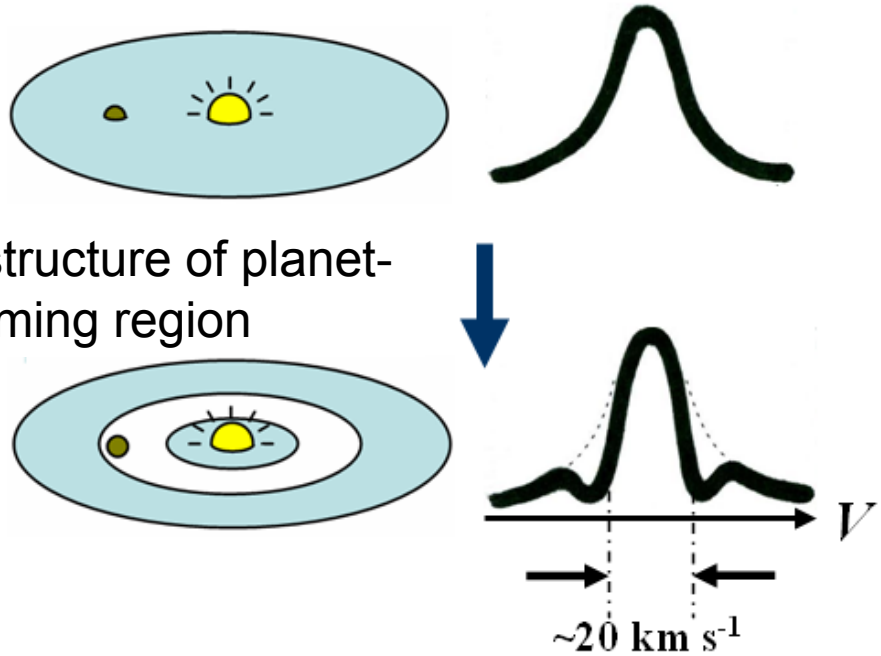
Key Targets





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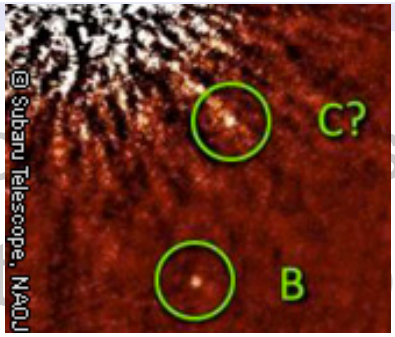
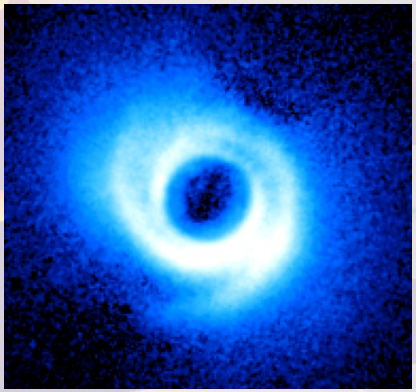


Proto-planetary Disk



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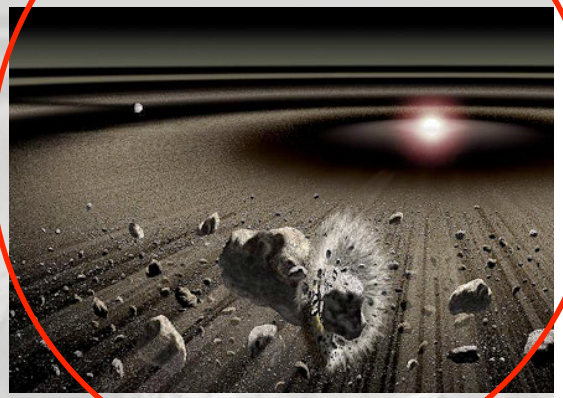

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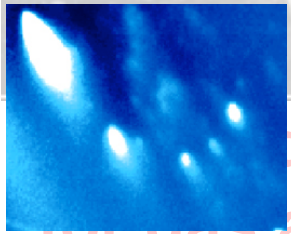
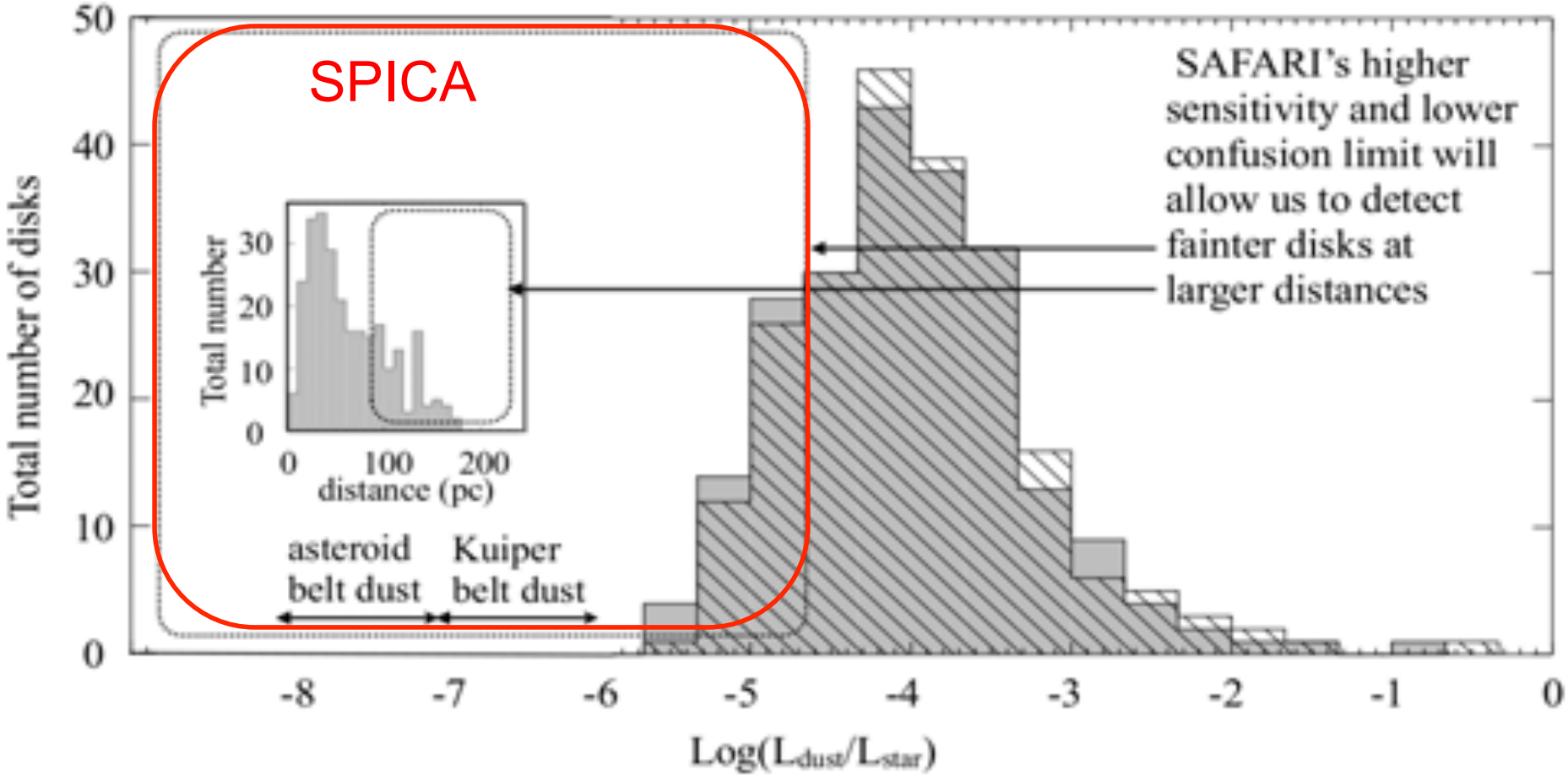
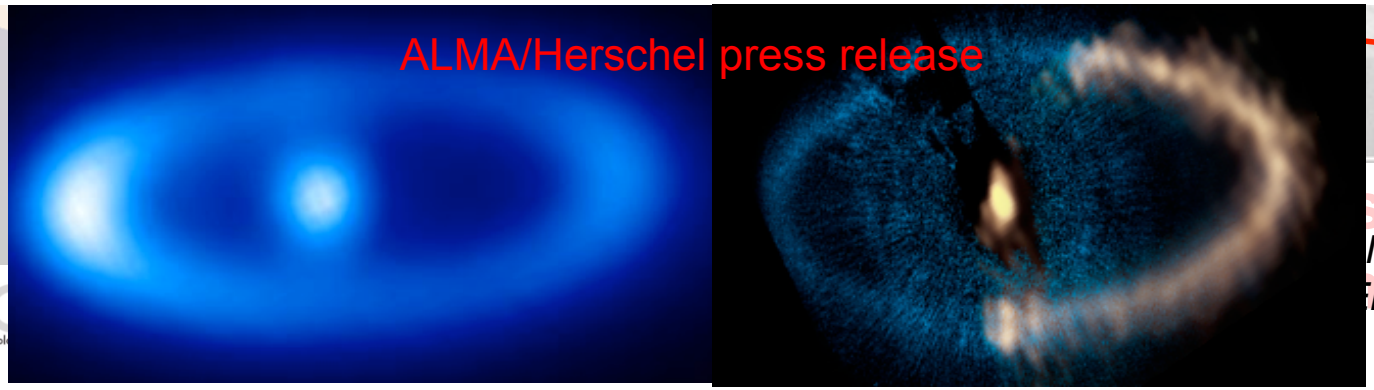


d Far-IR observations for gas and dust phases

Courtesy to M. Takami & Subaru/SEED team

What are the conditions for stellar and **Key Targets**





servations

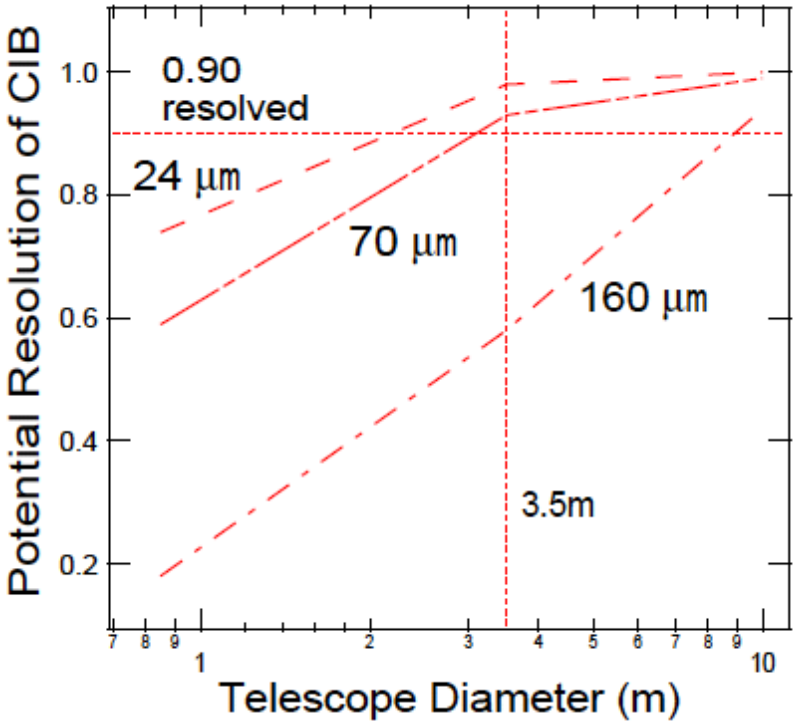
M. Takami &

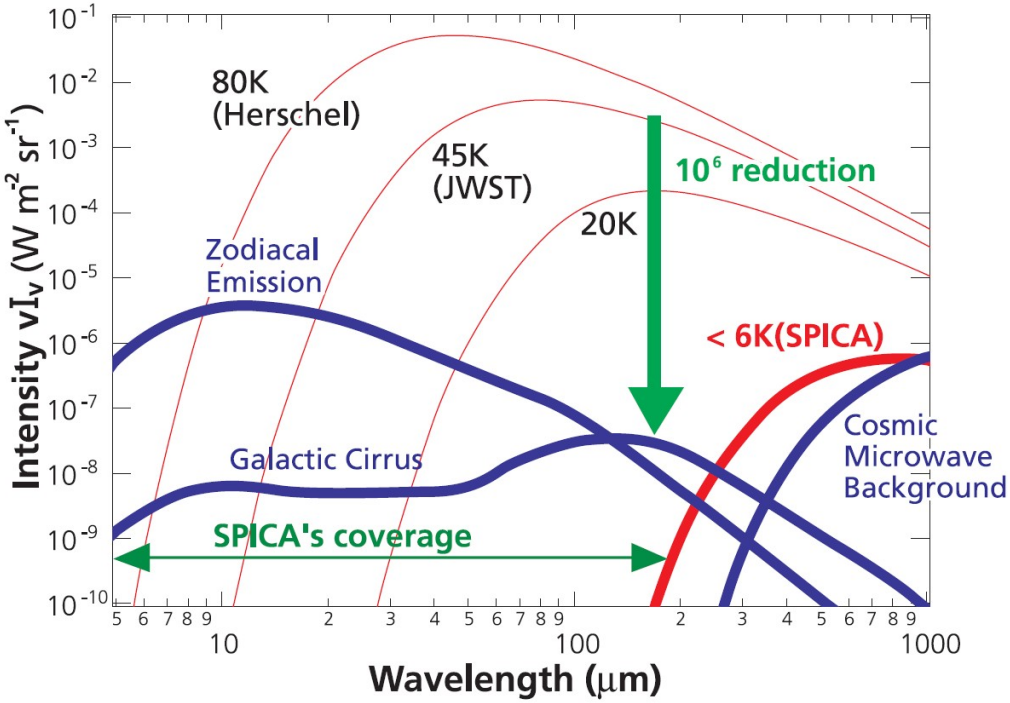
D team

SPICA
Space Infrared Telescope for Cosmology & Astrophysics

Key Science Requirements

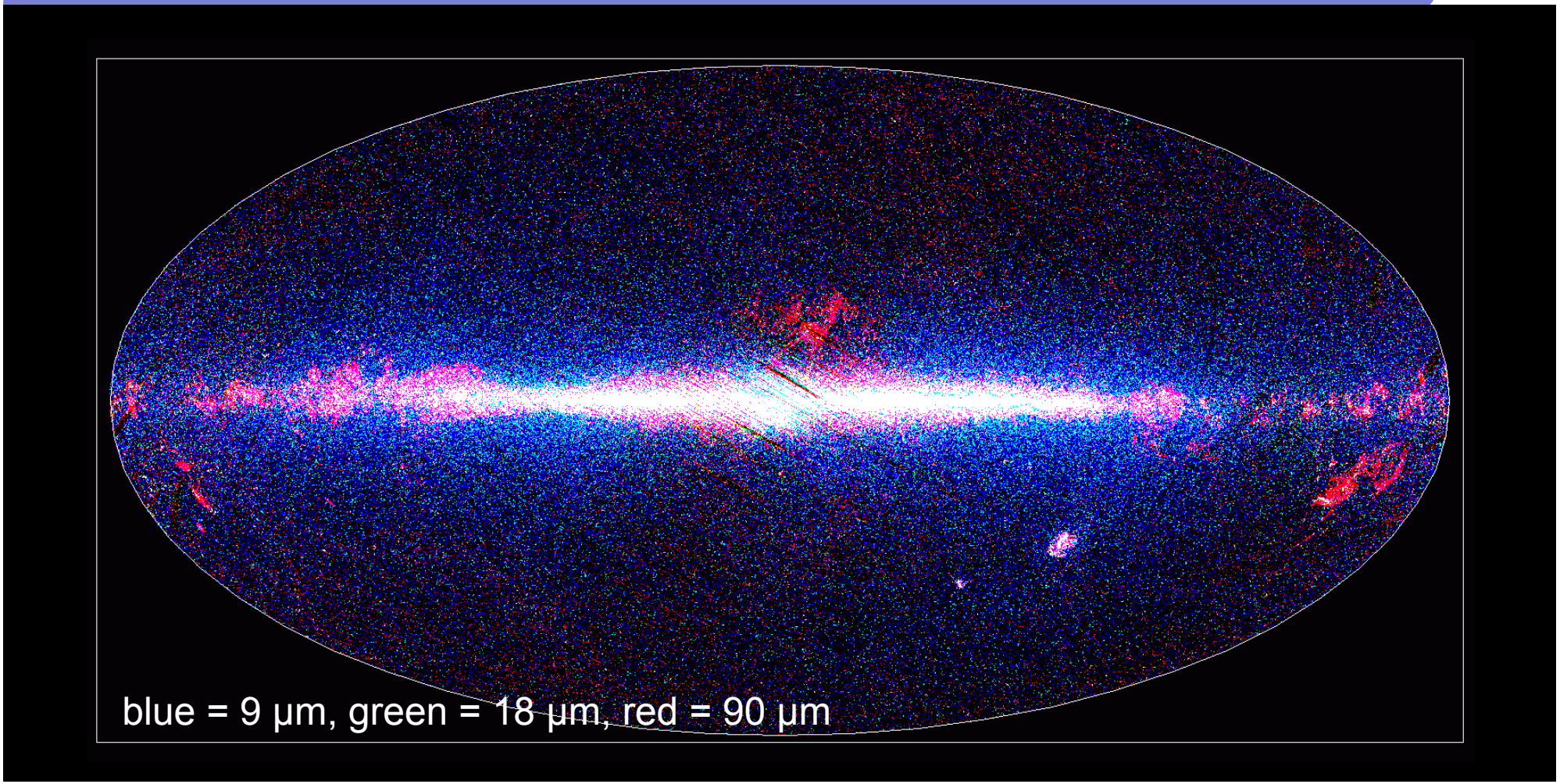
- High spatial resolution • High sensitivity
  - → 3m-class telescope → T<10K





Space Infrared Telescope for Cosmology and Astrophysics

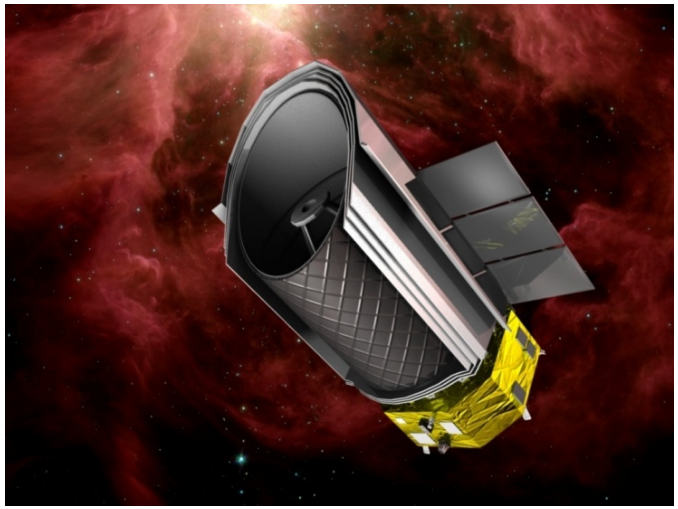
AKARI Heritage

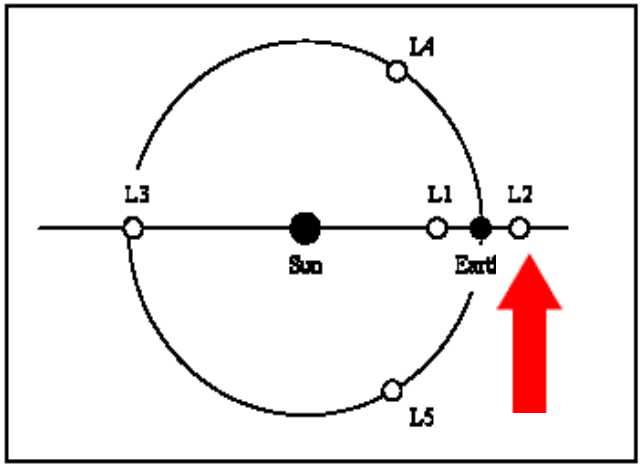


- Ideal inputs for SPICA
  - 0.9 million sources in MIR, 0.4 million sources in FIR

SPICA Mission Overview

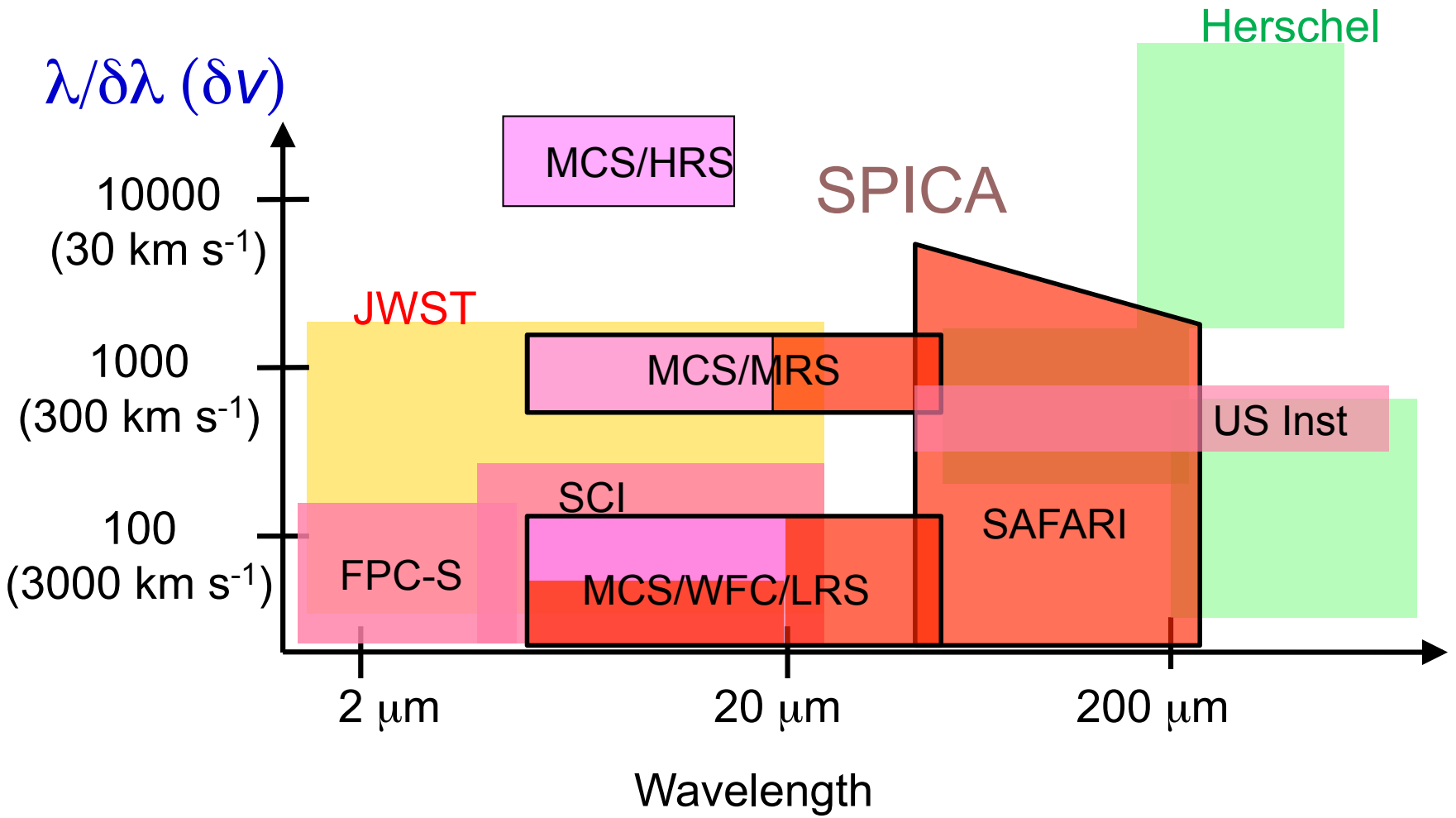
- Telescope: 3.2m (EPD 3.0m), 6 K
  - Superior Sensitivity
  - Good spatial resolution
- Core wavelength: 5-210 μm
  - MIR Instrument
  - Far-Infrared Instrument (SAFARI)
- Orbit: Sun-Earth L2 Halo
- Mission Life
  - 3 years (nominal)
  - 5 years (goal)
- Weight: 3.7 t
- Launch: 2022
- International mission
  - Japan, Europe, Korea, Taiwan, (USA)





SPICA
Space Infrared Telescope for Cosmology and Astrophysics

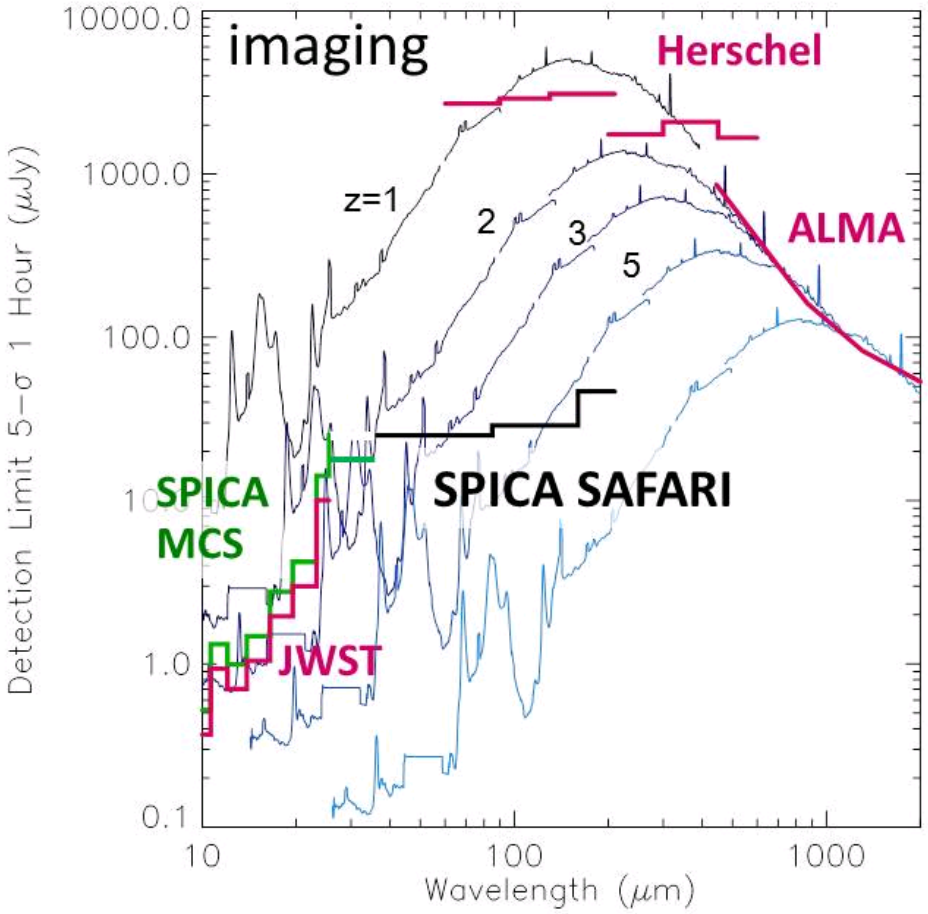
Focal Plane Instruments
Wavelength coverage vs Resolving Power

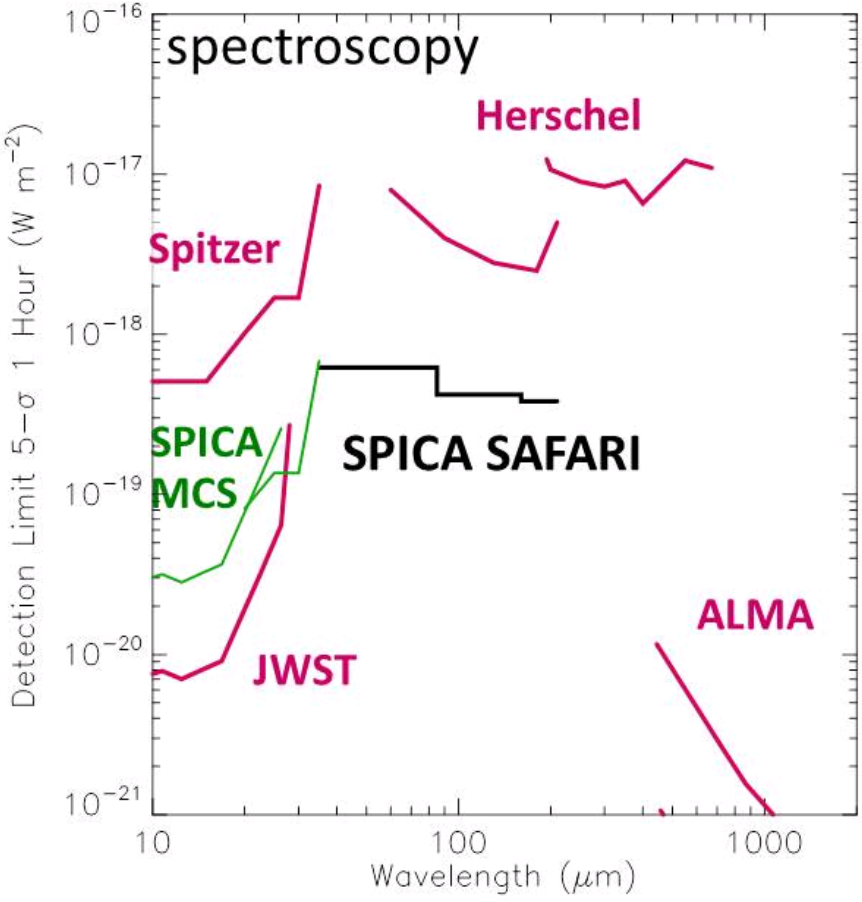


SPICA Space Infrared Telescope for Cosmology and Astrophysics

Unique Capability of SPICA/FPIs

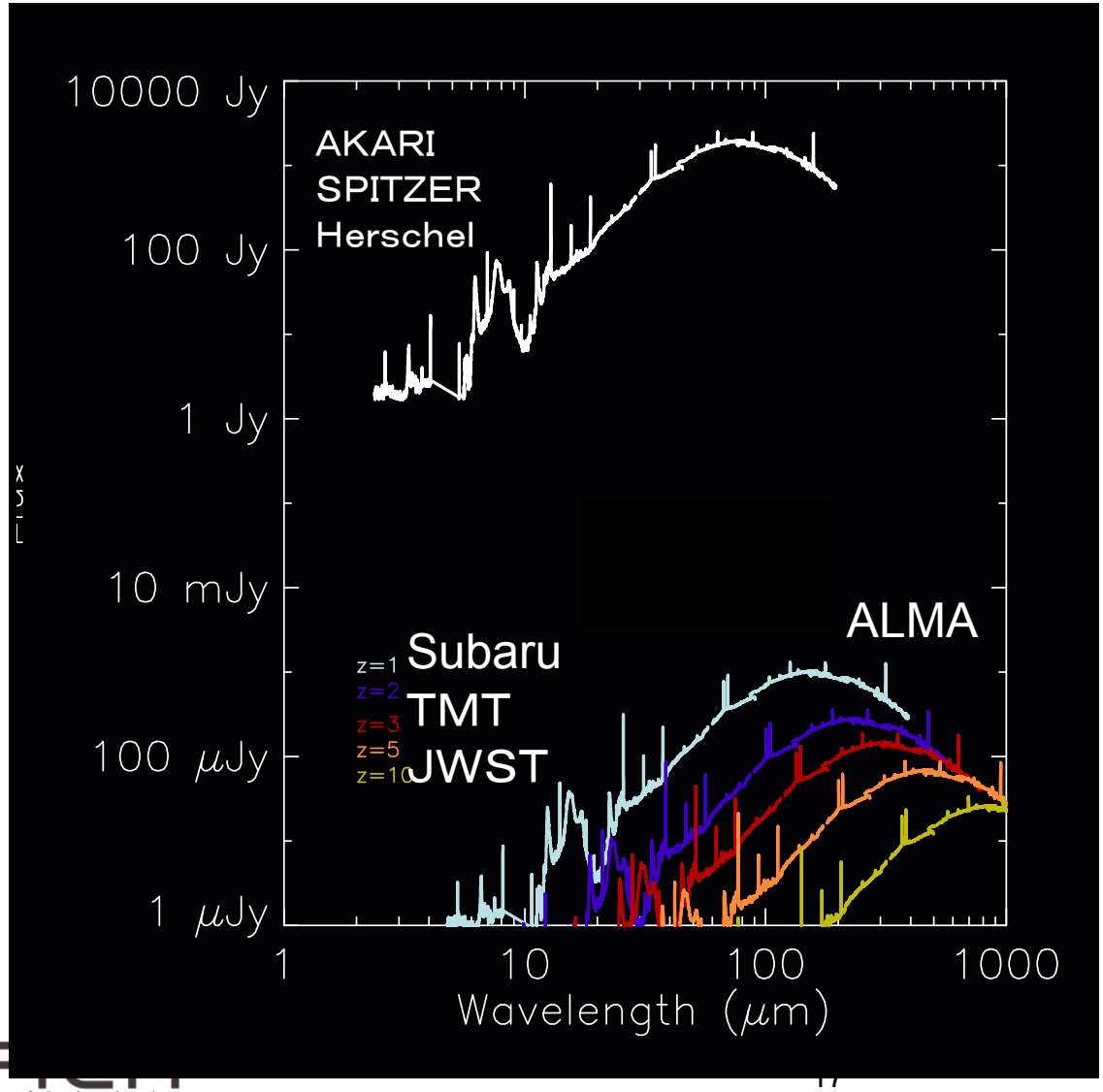
Huge Gain of Sensitivity





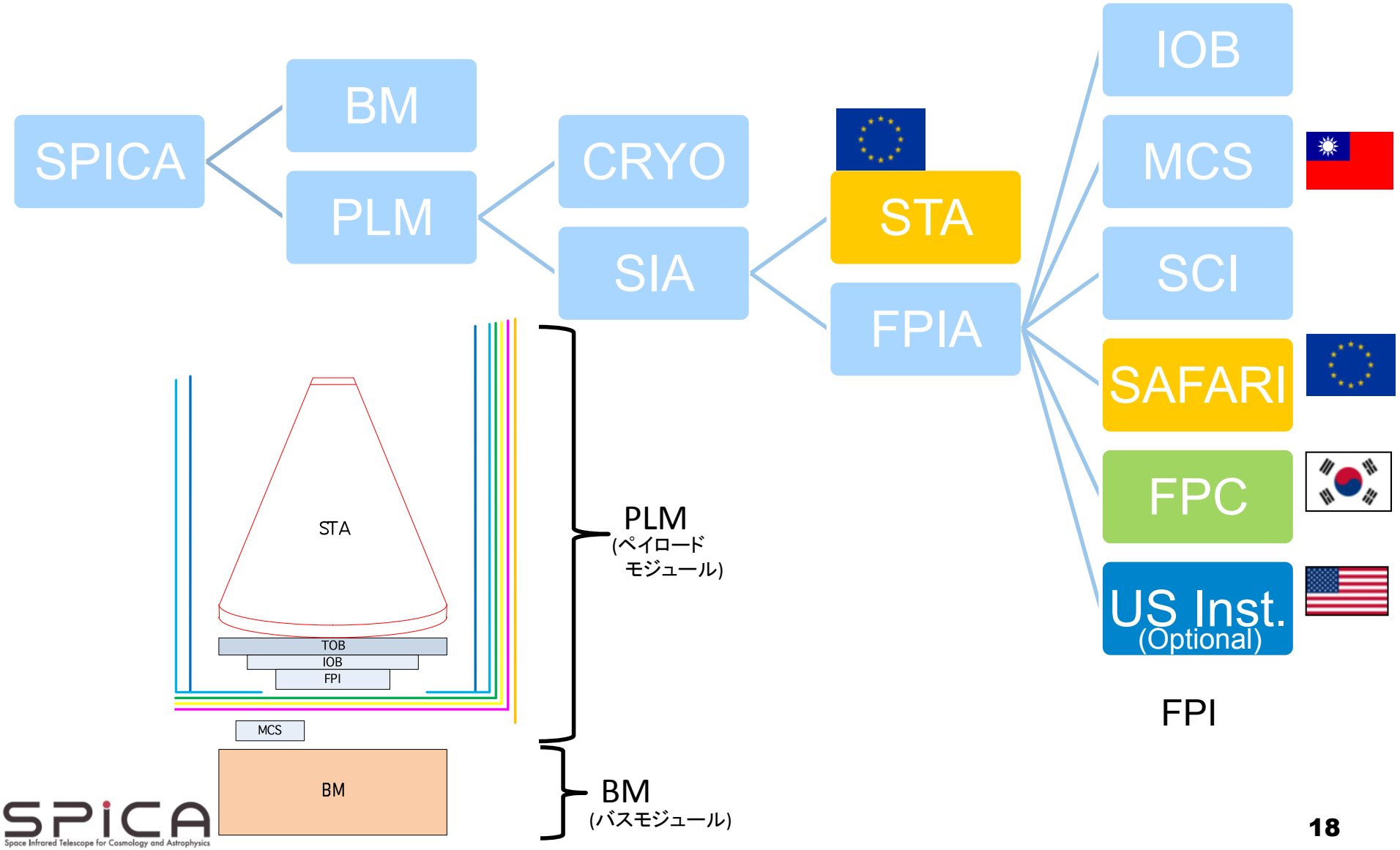
Space Infrared Telescope for Cosmology and Astrophysics

Synergy with (future) Large Facilities – Unveiling Cosmic Histrory



1. Subaru, TMT: unobscured star-formation, BH evolution
2. ALMA: veryhigh-z universe, ISM
3. **SPICA will unveil the entire SED, critical to resolve the history of Universe**

International Collaboration



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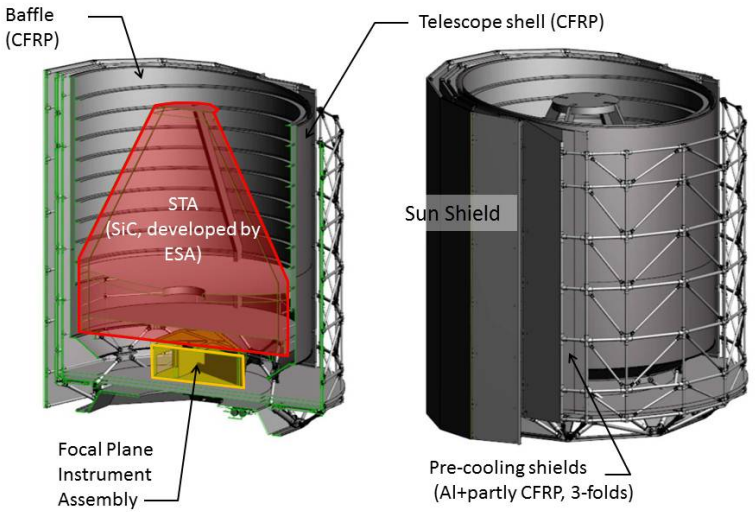
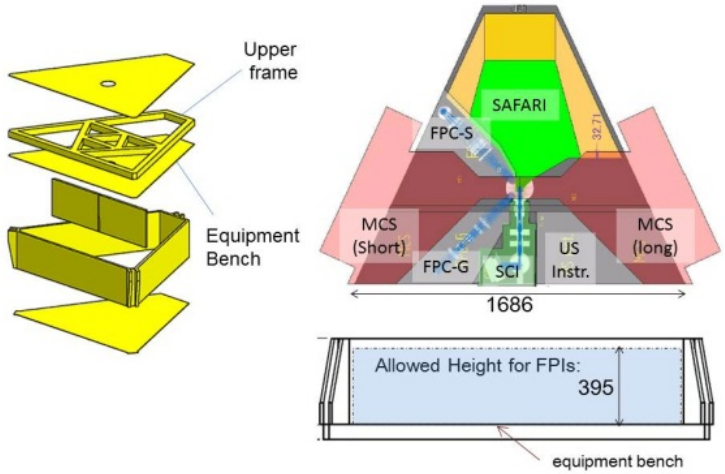
SPICA Focal Plane Instruments





- SAFARI
  - Far-infrared imaging spectrometer
  - P.I. SRON (Netherlands) with SAFARI Consortium
- MCS
  - Mid-infrared camera & spectrometer
  - P.I. JAXA, Universities, and ASIAA (Taiwan)
- SCI
  - SPICA coronagraphic instrument
  - P.I. JAXA with Nagoya Univ.
- FPC
  - Near-infrared camera and spectrometer
  - P.I. KASI (Korea)
- US Instrument (Optional)
  - Far-infrared, sub-mm spectrometer
  - P.I. TBD (NASA funded)

SPICA
Space Infrared Telescope for Cosmology and Astrophysics

MCS & SAFARI

Name	Mid-IR Camera and Spectrometer (MCS)		SPICA Far-IR Instrument (SAFARI)		
Imaging					
Channel	WFC-S	WFC-L	SW	MW	LW
Wavelengths (μm)	5 – 25	20 – 38	34–60	60–110	110–210
Field-of-Views	5' x 5'	5' x 5'	2' x 2'		
Array format	2k x 2k	1k x 1k	43 x 43	34 x 34	18 x18
Sensitivity for point source (*)	0.13-3.5 μJy (5σ, 1hour)	5-8 μJy (5σ, 1hour)	<20μJy (5σ, 1hour)		
Spectroscopy					
Channel	MRS-S	MRS-L	Same as Imaging mode (i.e. imaging Fourier Spectrometer)		
Wavelengths (μm)	12.2 – 23.0	23.0 – 37.5			
Field-of-view	12"x6"	12"x7".5			
Spectral resolution	1900-3000	1100-1500	150 (SED mode) , 2000@100μm		
Sensitivity for point source	~300μJy (in 5σ, 1 hour for continuum)	~1mJy (in 5σ, 1 hour for continuum)	a few x 10^{-19} W/m^2 (in 5σ, 1 hour for spectral lines)		

JAXA PI
(Tokyo Univ, ASIAA)

SRON PI
(SAFARI Consortium)

SPICA
Space Infrared Telescope for Cosmology and Astrophysics

Programmatic progress at JAXA

- 2008: Official start of SPICA Preproject
- 2008: MDR (Mission Definition Review)
- 2010: SRR (System Requirement Review)
- **2012-13: Risk Mitigation Phase**
  - roughly equivalent to Phase B1
  - The risk mitigation activities, which were formerly planned to be the part of the Phase B after the approval of the project, are now to be performed prior to formal approval of the project.
- Following successful risk mitigation phase activity, SDR (System Definition Review) and Phase-up review are expected in FY2013.

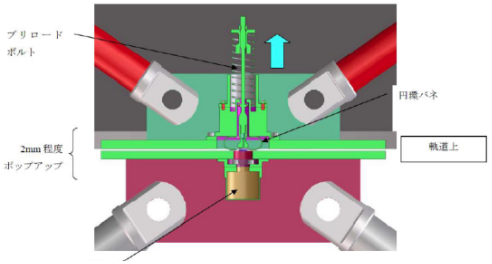
Risk Mitigation Phase: Steps

- In order to mitigate risks efficiently, activities will be taken in the following two phases:
  - Phase #1 (RMP1)
    - Mainly desk works (studies, analysis)
    - Issues requiring the technical demonstration, its details will be investigated
  - Phase #2 (RMP2)
    - Detailed risk mitigation activities, including the technical demonstration (BBM development & test)
    - An Industry which is responsible for the technical demonstration will be selected by an appropriate manner.
- During the entire Risk-Mitigation phases, the pre-project team will work together with the SE office, Project Office of JAXA.
- JAXA, ESA, and SAFARI team are requested to continue to work closely together to carry out the risk mitigation plan.

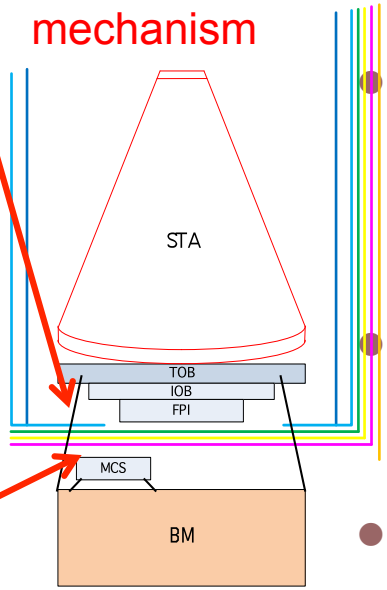
RMP#1 Activities Overview

- In the risk mitigation phase, we focus on risks which could affect the success of the mission.
- The SPICA preprojet team identified the following four items as the major risks. This identification is consistent with that of the independent review team.
  - 1. **PLM thermal** requirements sometimes contradict with mechanical requirements, and coordinated design between thermal and structural requirements are required.
  - 2. **Pointing control** requirements of SPICA is very stringent, especially under the influence of the mechanical cryocoolers jitter.
  - 3. SAFARI is very sensitive to **EMI**.
  - 4. **Focal plane instruments** have unpredicted aspects, which could be the risks of the project.

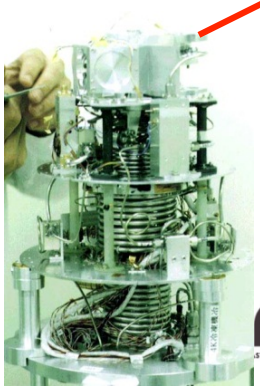
Highlights of RMP#2 Activities



Truss separation mechanism



Cryo-coolers



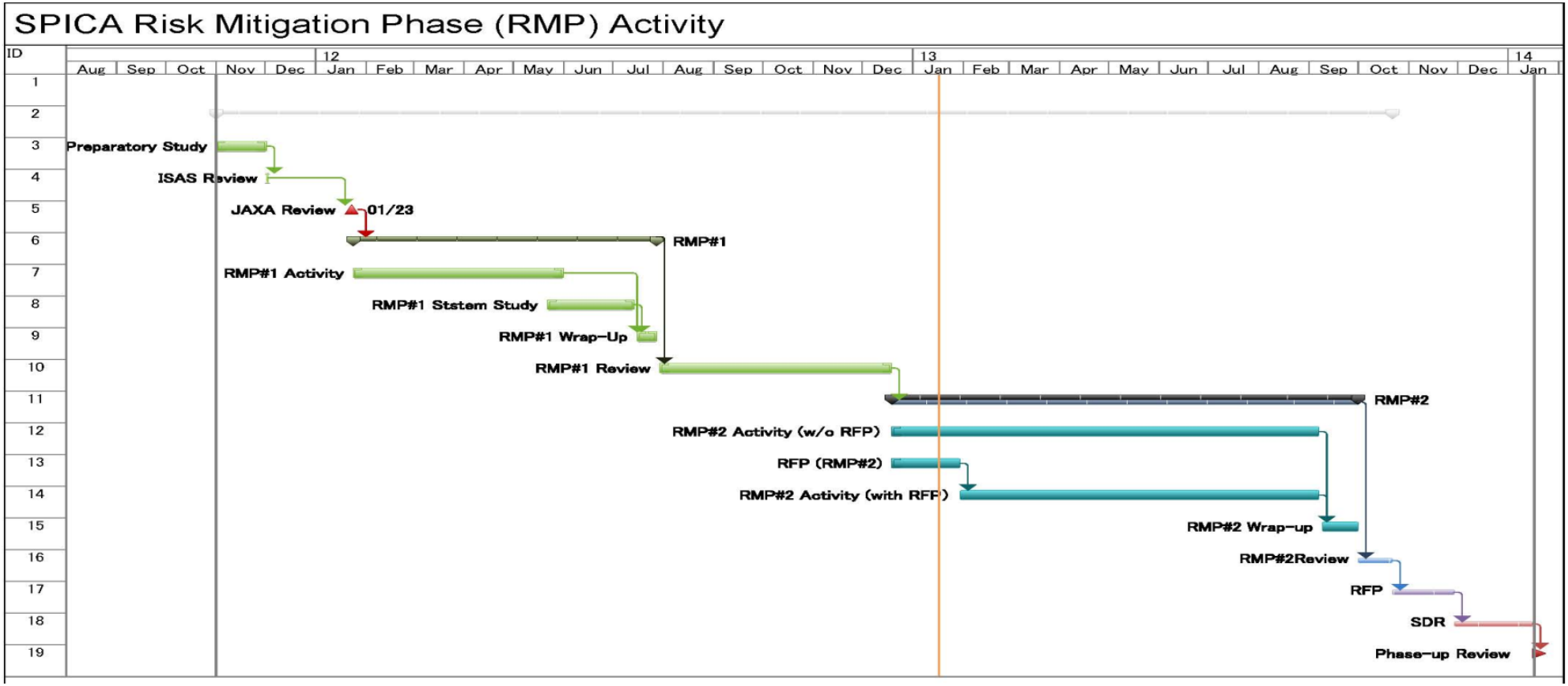
- Approved on 12 Dec. 2012
- PLM Thermal & Mechanical Issues
  - End-to-end consistent thermal design
  - Breadboarding of Main Truss Separation Mechanism
  - Components: Heat switch & coolers
- Pointing
  - Compatibility with FPI Requirements
  - Breadboarding of Vibration Isolation mechanism
  - Breadboarding Active control mechanism
- EMC
  - Compatibility with FPI requirements
    - Antenna, DC-DC Conv., Cryocoolers, etc.
- FPI
  - Consistent design of cryoharness
  - Optimization of FPI configuration
- Active Participation of ESA and SAFARI to RMP#2 is essential for the success of RMP#2.

SPICA Promotion Team Activity

- SPICA Promotion team was established at JAXA/HQ to discuss the following issues.
  - How programmatic promotion of the SPICA preproject can be done
  - How the SPICA team can be reinforced
  - How the international discussion scheme on SPICA can be reinforced.
  - Members consist of not only from ISAS but also from JAXA HQ
- At the beginning of RMP#2, the final report was released with the following statement:
  - Additional member(s) should be added to the SPICA team to work on the programmatic issues of the SPICA preproject

Short-term Schedule

The whole RMP#2 activity is now expected to end by September, 2013.
RMP#2 results review (technical review, Oct., 2013)
Phase-up Review (management review, Jan. 2014)



International SPICA Team

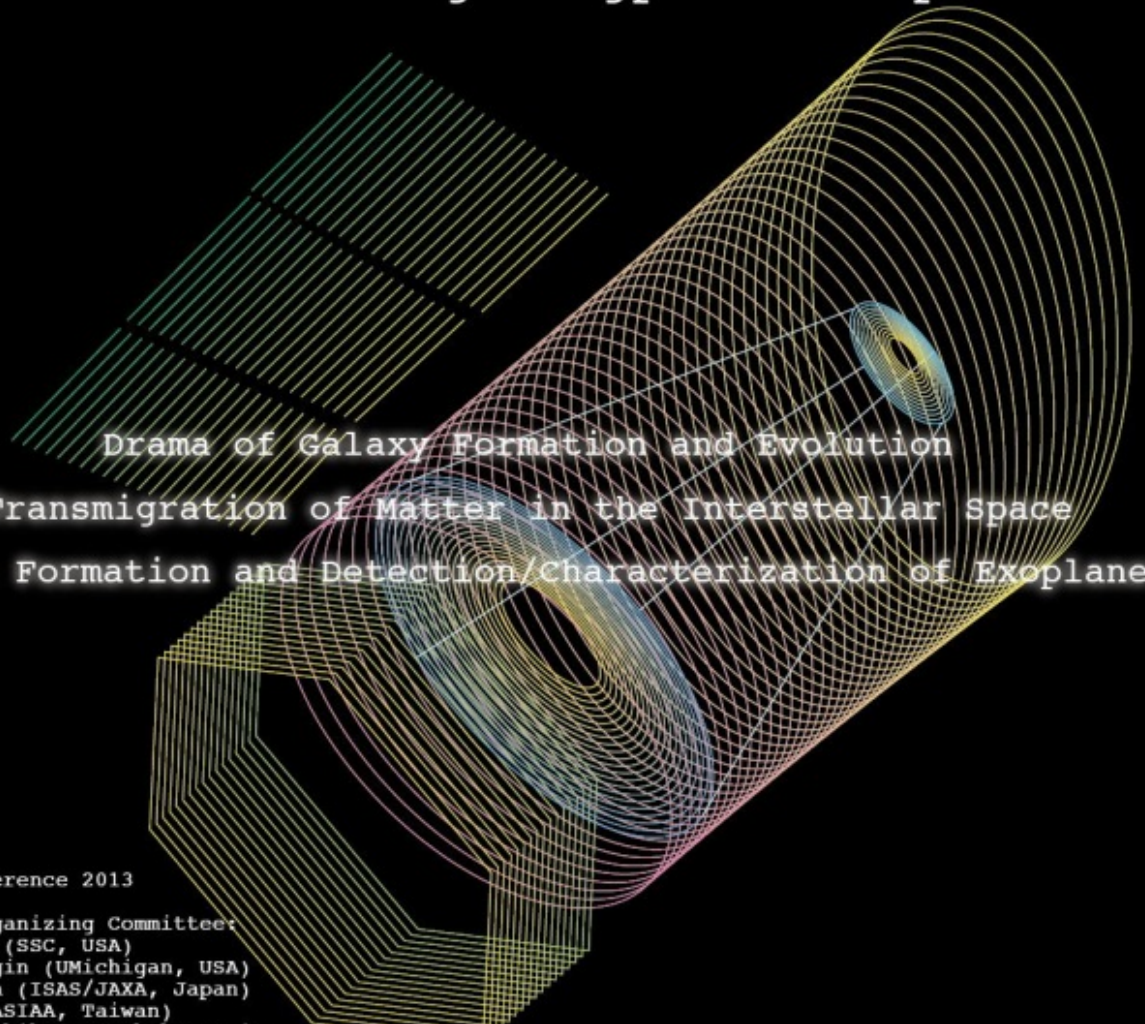
- 17 countries, regions and one International org.

From Exoplanets to Distant Galaxies:

SPICA'S NEW WINDOW

on the Cool Universe

18th-21st June 2013
The University of Tokyo, Japan
http://www.ir.isas.jaxa.jp/SPICA/spica2013/



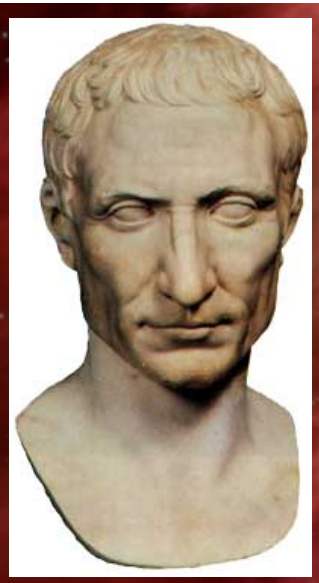
Drama of Galaxy Formation and Evolution

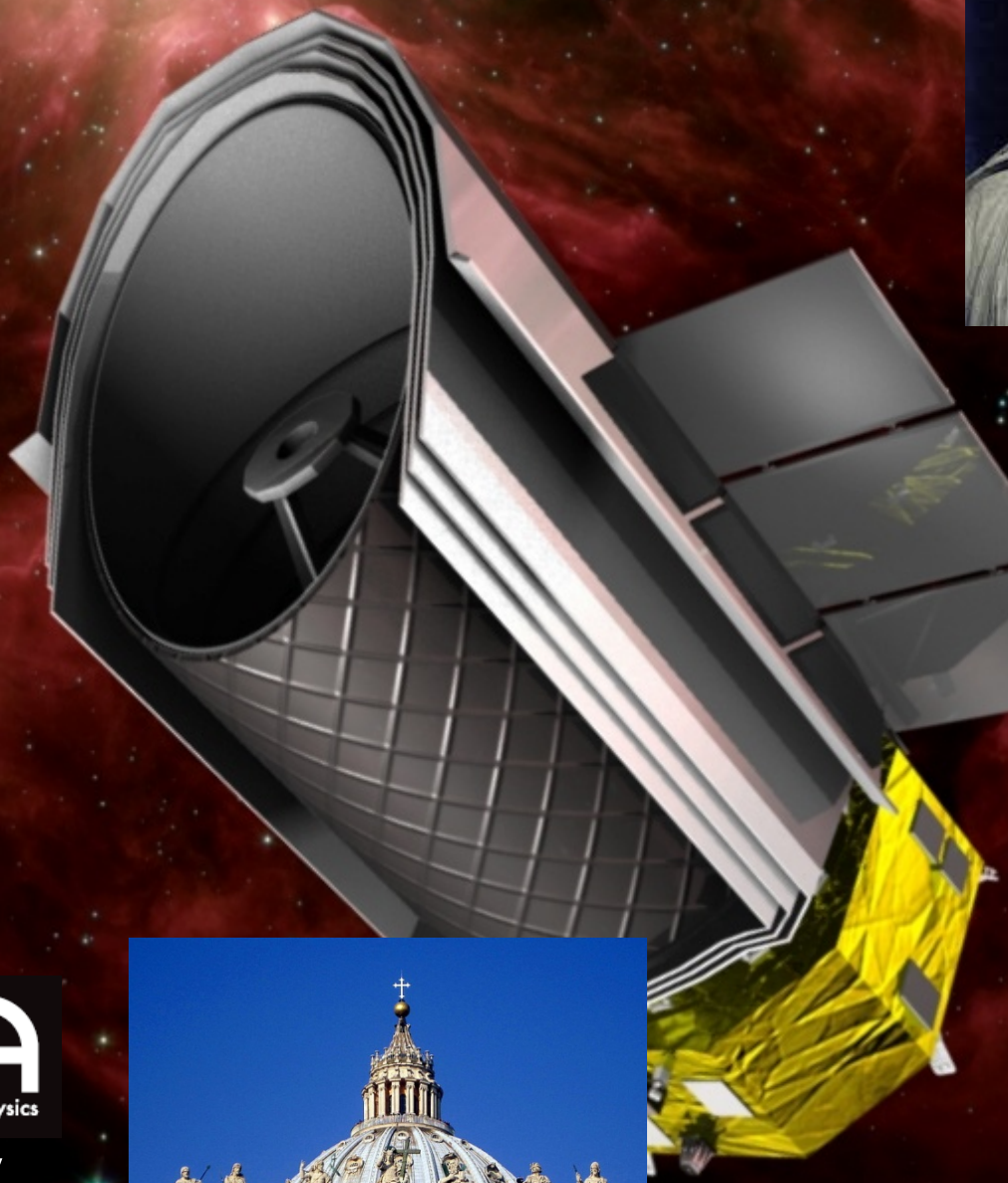
Transmigration of Matter in the Interstellar Space

Planet Formation and Detection/Characterization of Exoplanets

SPICA conference 2013

Science Organizing Committee:
Lee Armus (SSC, USA)
Edwin Bergin (UMichigan, USA)
Keigo Enya (ISAS/JAXA, Japan)
Paul Ho (ASIAA, Taiwan)





SPICA

Space Infrared Telescope for Cosmology and Astrophysics

Space Odyssey