



# Subaru/Gemini MIR Observations of Warm Debris Disks



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# Outline

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- Introduction: Debris Disks
- AKARI/IRC 18  $\mu\text{m}$  Survey of Warm Debris Disks
- Subaru/Gemini Follow-up Observations
- Summary and Future Prospects

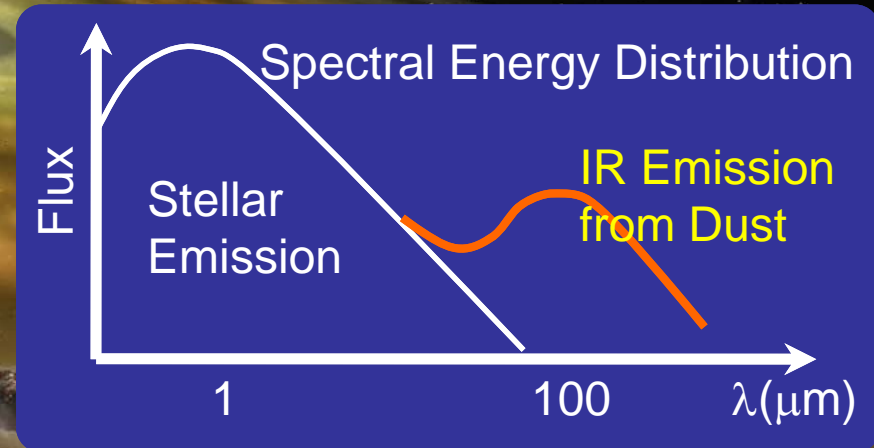
# Debris Disk = Extrasolar Zodiacal Light

- Debris Disk

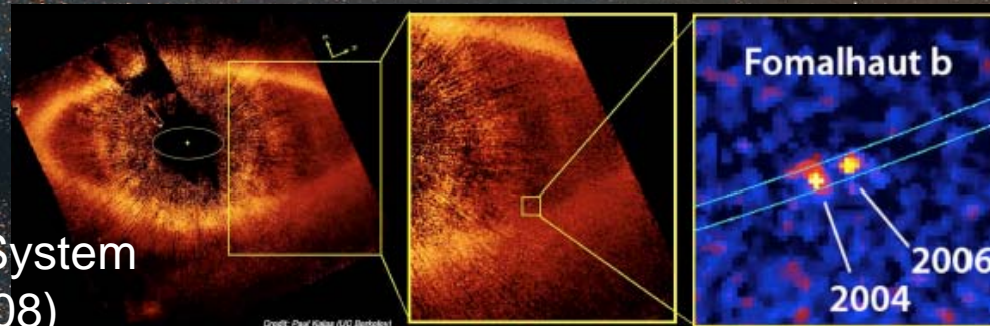
- Dust Disks around MS stars
- More than 100 samples

- Infrared Excess

- Thermal emission from circumstellar heated by central star
- Infrared excess over photospheric emission
- 1<sup>st</sup> sample – Vega with IR Excess at  $\lambda > 25\mu\text{m}$  by IRAS (Aumann+ 84)
- Possible connection with planets



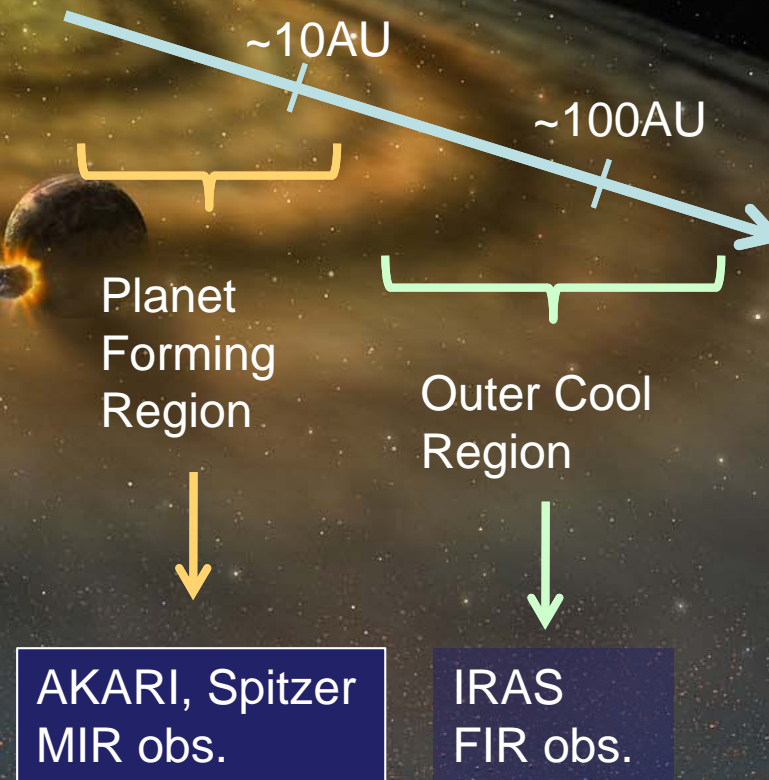
Planet in Debris Disk System  
Fomalhaut (Kalas+ 2008)





# Warm Debris Disks

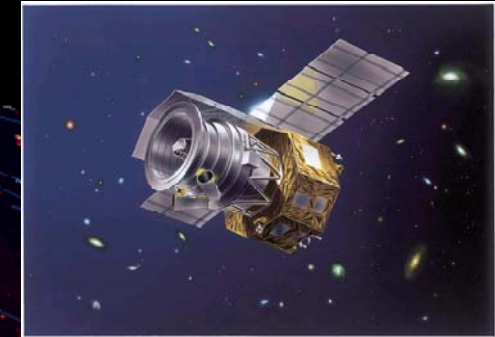
- Main stream after IRAS
  - Far-infrared observations that can trace low-temperature dust ( $\sim 100\text{K}$ )
  - Outer region of debris disk ( $\sim 100\text{AU}$ )
  - Kuiper-belt analog
- More interesting thing (for me) is ...
  - Situation in planet forming region
  - Traced by “Warm Debris Disk” at  $\sim 1\text{-}10\text{AU}$  from star (Asteroid analog)
  - MIR excess emission from warm dust
- AKARI, Spitzer
  - MIR observations with high sensitivity
  - Studies of warm debris disks have begun in earnest



# AKARI MIR All-Sky Survey

- AKARI: a Japanese IR satellite (surveyor)

- IRC: Near~Mid-IR & FIS: Far-IR
- All-sky survey with higher sensitivity and spatial resolution than IRAS
- MIR IRC survey (9&18 $\mu$ m) is useful for warm debris disk search

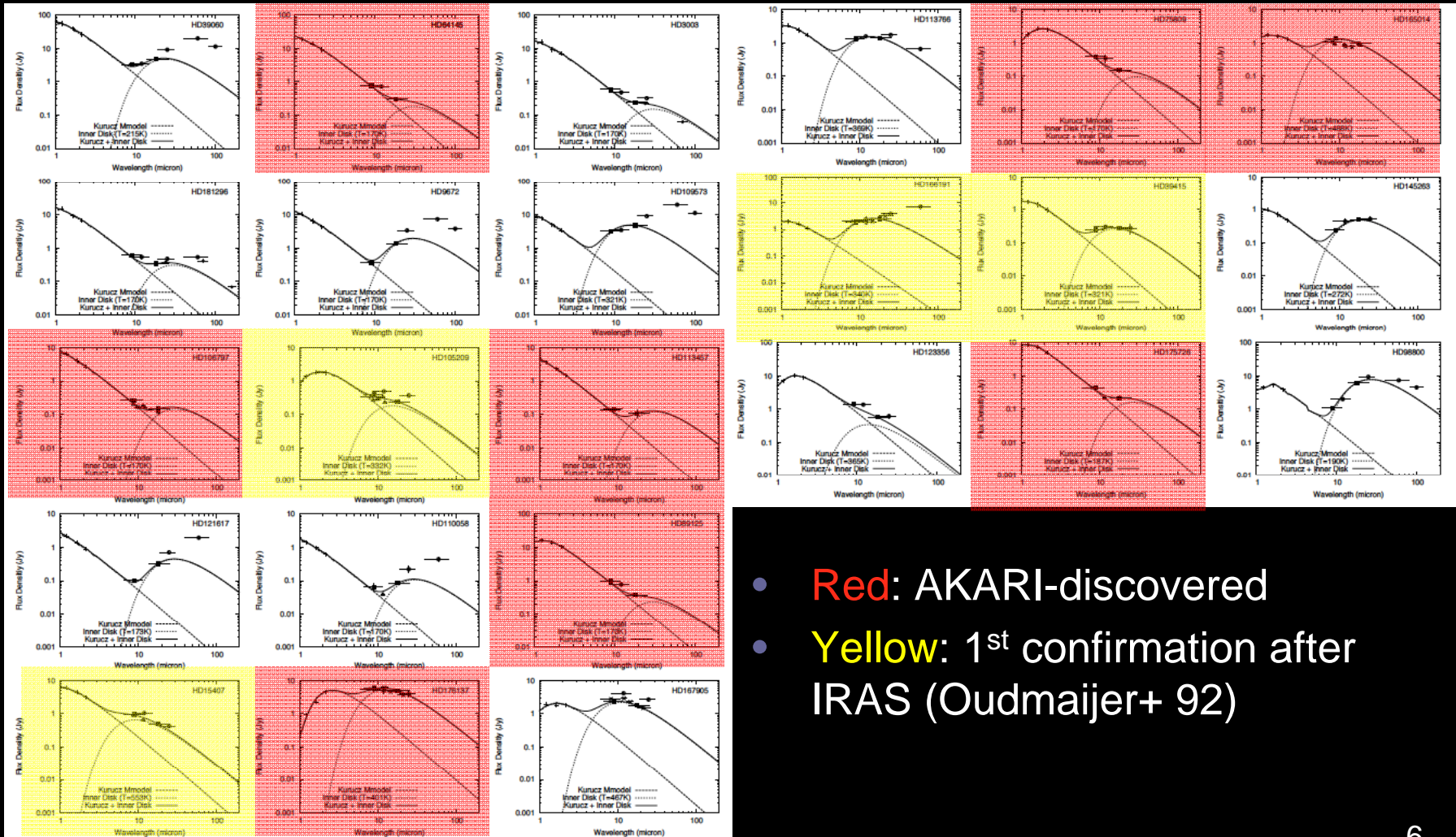


- Warm debris disk survey by comparing AKARI, 2MASS and Tycho-2 Spc catalog

Band	S9W	L18W
Wavelength	6-12 micron	14-26 micron
Sensitivity	50 mJy	120 mJy
Resolution		9.4"



# AKARI-identified Debris



- **Red:** AKARI-discovered
- **Yellow:** 1<sup>st</sup> confirmation after IRAS (Oudmaijer+ 92)



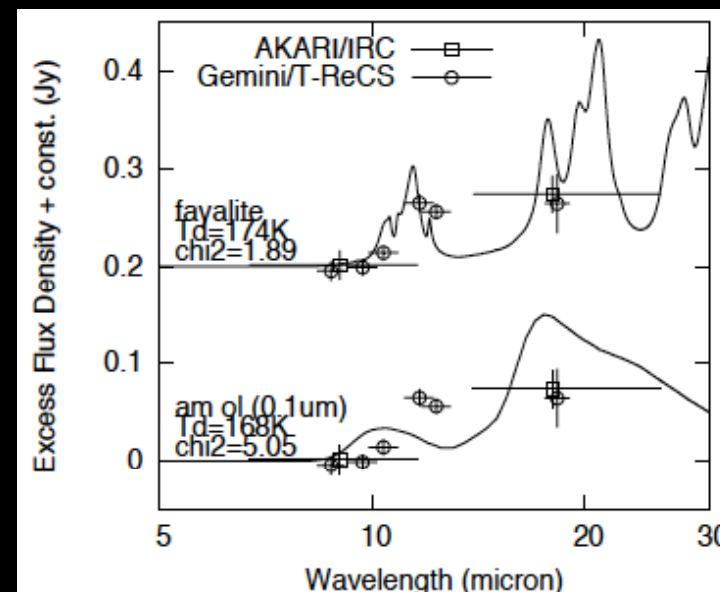
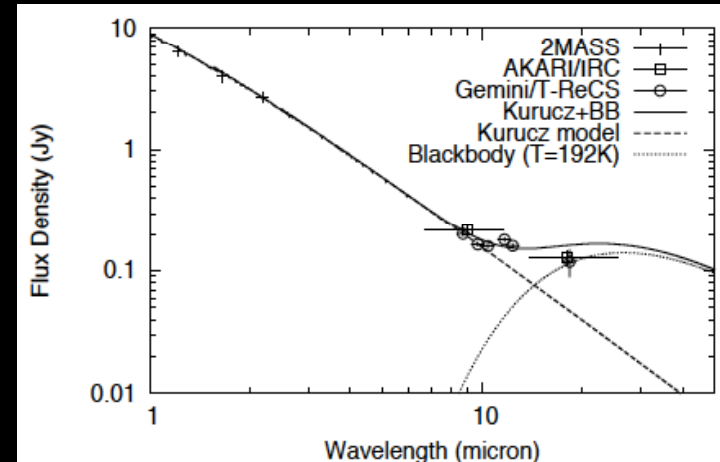
# Follow-up Observations

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- Observations from space
  - Limited spatial resolution of observation from space
  - Suspicious of contamination/mis-identification
- Ground-based follow-up observations
  - Higher spatial resolution
  - Confirmation of excess emission
- High spectral resolution/multiple bands
  - Hints for properties (dust temperature and species)
- Availability of MIR capability in both of Northern and Southern Hemisphere
  - AKARI candidates distribute in all sky
  - Subaru/COMICS + Gemini-S/T-ReCS

# HD106797 by Gemini/T-ReCS

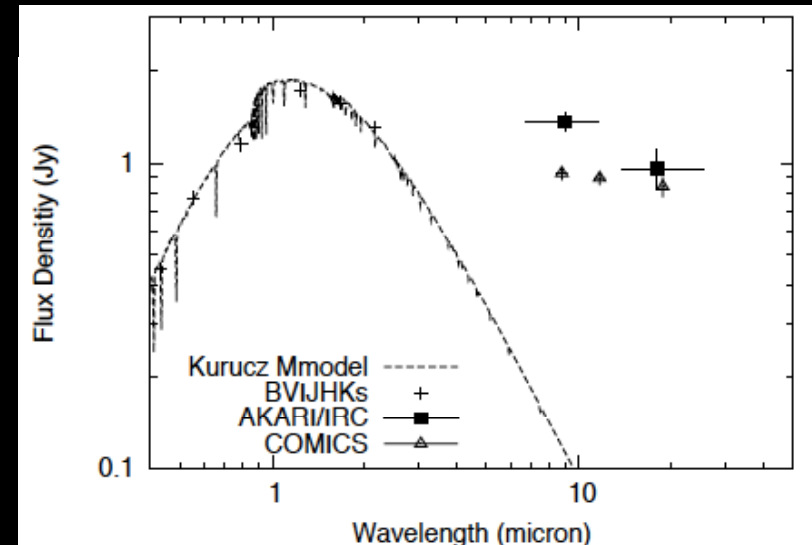
- A-type dwarf star
  - 18 $\mu\text{m}$  excess by AKARI
- Gemini/T-ReCS
  - Si2-6 and Qa
  - Excess at  $\lambda > 11\mu\text{m}$
  - Dust T $\sim$ 200K
- Feature Shape
  - Crystalline silicate?
  - Not sub- $\mu\text{m}$  amorphous (ISM-like) silicate





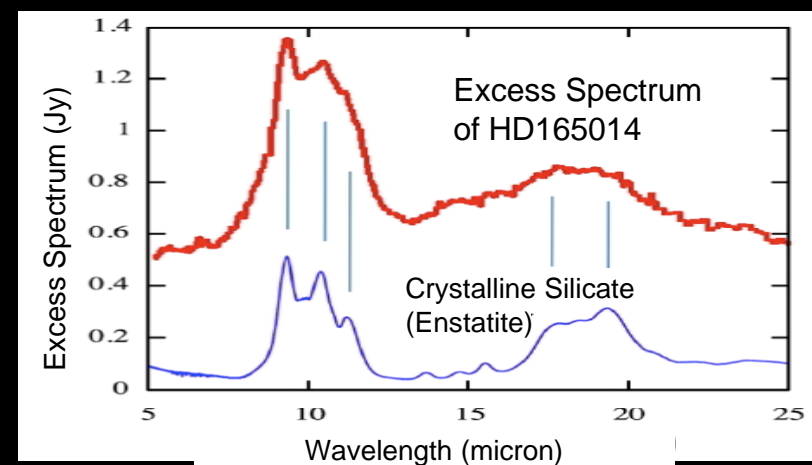
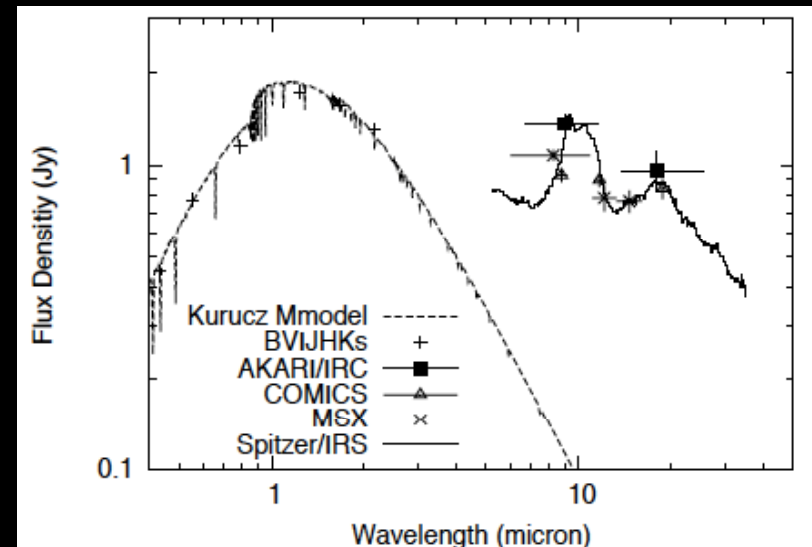
# HD165014 by Subaru/COMICS

- A-type dwarf star
  - 9&18 $\mu$ m excess by AKARI
- Subaru/COMICS
  - 8.8, 11.7, 18.8 $\mu$ m
  - Large Excess at  $\lambda > 8\mu$ m
  - Dust  $T > 200\text{K}$  (500K?)
  - $L_{\text{dust}}/L_{\text{star}} \sim 5 \times 10^{-3}$ 
    - Comparable to b Pic
- Dust Feature by Spitzer
  - Crystalline silicate



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- Dust Feature by Spitzer
  - Crystalline silicate





# Summary

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- AKARI identified 24 warm debris disk candidates
- 6 candidates confirmed by Subaru/Gemini follow-up observations so far
- Crystalline silicate towards 2 candidates
  - Dust evolution during planetesimal formation?





# Future Prospects

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- MIR follow-up observations of 18 candidates
- MIR spectroscopy for dust property examination
- Coronagraph observations for direct detection of disks (HiCIAO/NICI)
  
- Availability of MIR capability in N/S hemisphere
  - important for follow-up observations of sources discovered by all-sky survey (AKARI/WISE/Planck)