

The background of the slide is a detailed illustration of a protoplanetary disk. At the center, a bright star is partially obscured by the inner disk. The disk itself is composed of concentric rings of gas and dust, showing a color gradient from blue and green in the inner regions to orange and red in the outer regions. In the foreground, several dark, rocky bodies of various sizes are scattered across the scene, some appearing to be in motion. A larger, reddish-brown planet is visible in the lower-left corner, partially cut off by the edge of the frame. The overall scene is set against a dark, star-filled space.

Highlights on Debris Disks from the Herschel Key Science Programmes

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Herschel Space Observatory

- Far-IR to sub-mm imaging and spectroscopy
- Three instruments
 - PACS, SPIRE, HIFI
- Launched May 2009
- Expected depletion of cryogen in early 2013



<http://herschel.esac.esa.int/>

GASPS

“Gas in Protoplanetary Systems”

PI: W. Dent (UKATC / ALMA JAO)

- 400 hours, ~ 250 late B to M stars, 1 – 30 Myr old
- Primordial disks through young debris disks
- Far-IR spectra & photometry

[C II], [O I], H₂O +
other data + models to
get gas masses

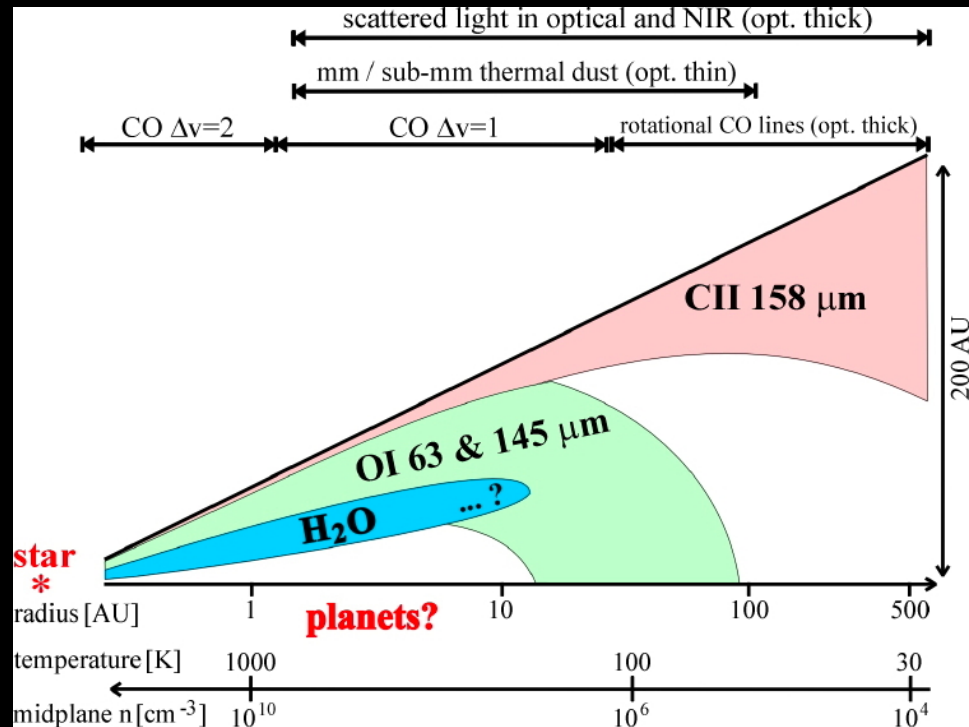


Image credit : I. Kamp

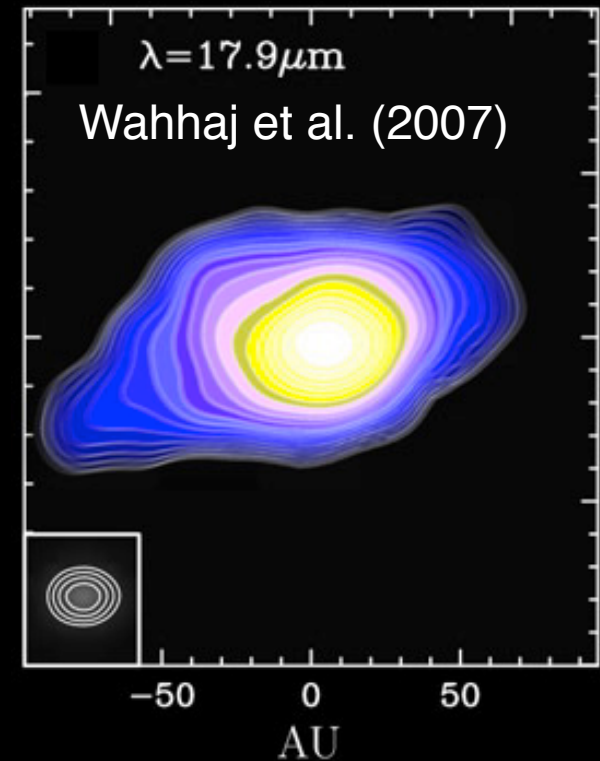
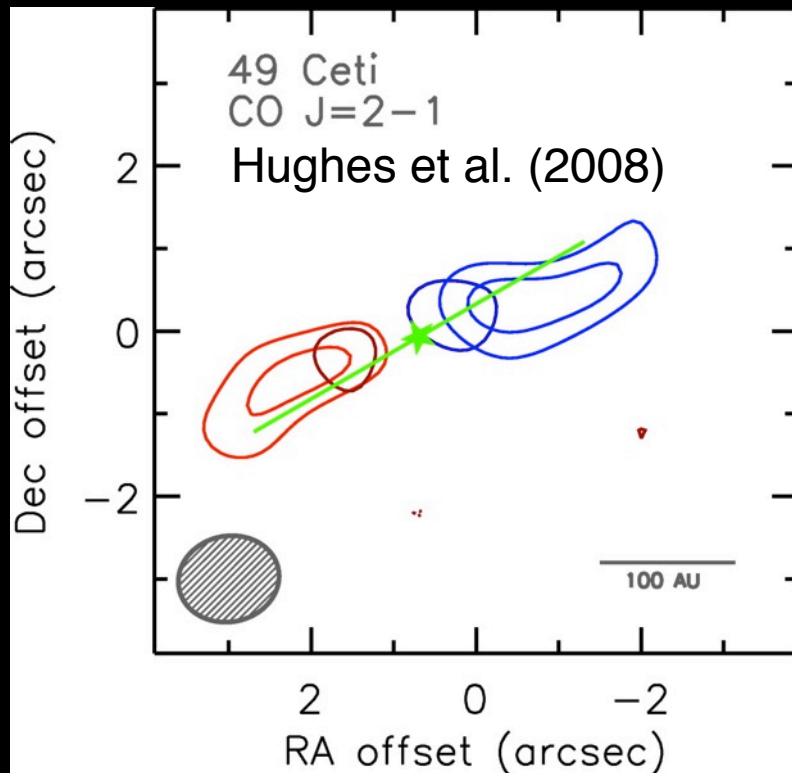
The 49 Ceti System

One of two debris disks
w/ sub-mm CO emission

(A1 star, 10 to 30 Myr-old)

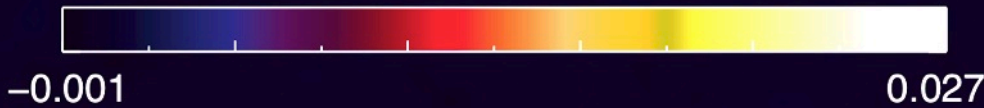
Warm inner disk,
cold outer disk.

Inner disk resolved



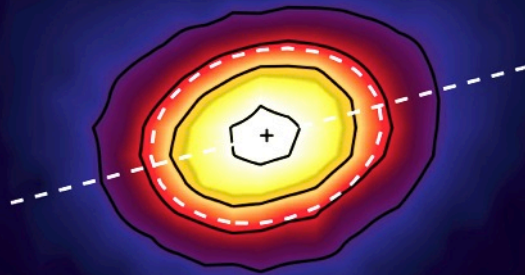
Dust in 49 Ceti with Herschel

Linear Scale



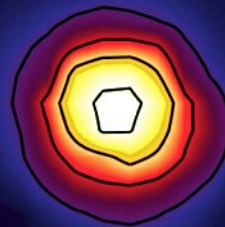
Disk resolved at 70 μm

70 μm



- HWHM \sim 250 AU
- PA agrees w/ sub-mm CO contours (-75° vs. -79° E of N)

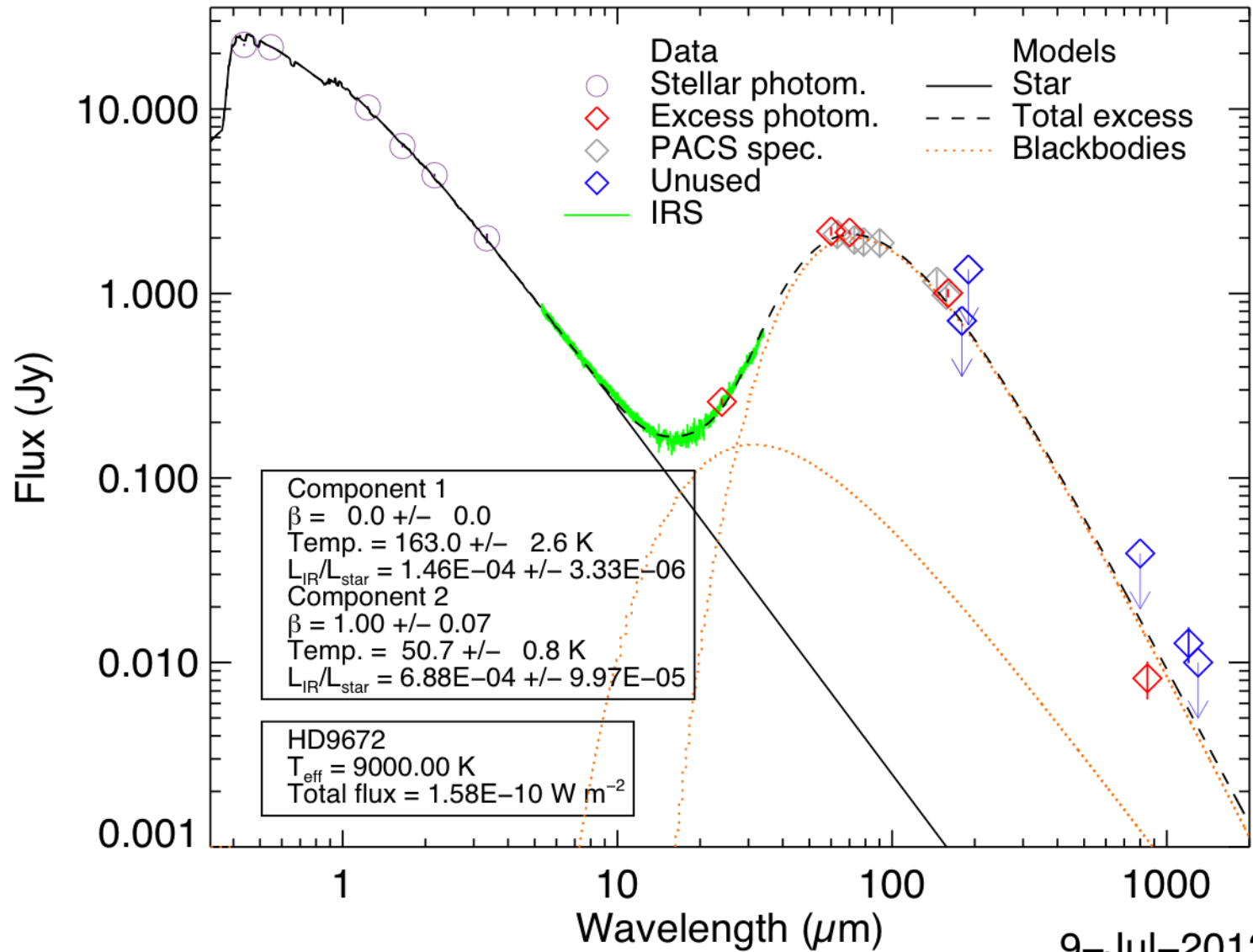
PSF



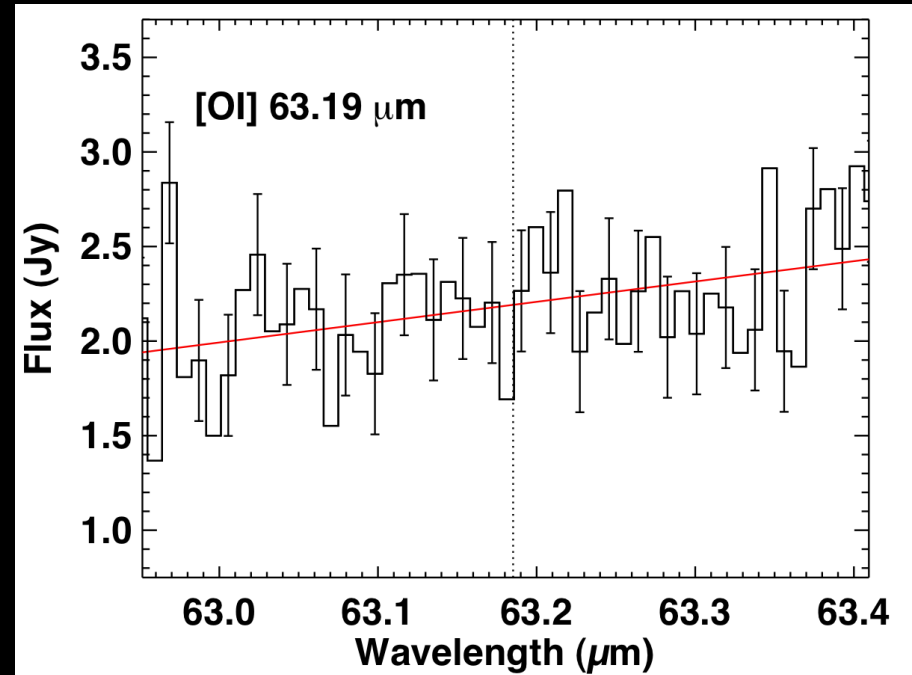
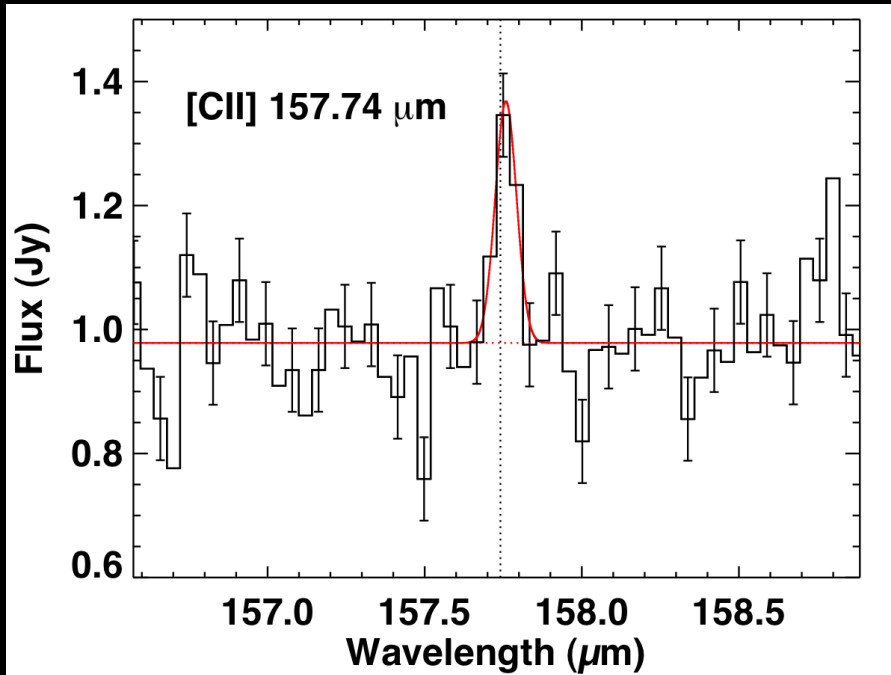
- Cold dust and cold gas appear to be aligned
- Disk might be warped



Dust in 49 Ceti with Herschel



Atomic Gas in 49 Ceti



Roberge et al. (2012), in prep.

- CII emission detected (5σ); No OI emission
- Can't fit the CII, OI upper limit, and CO emission with a primordial-like gas disk model

DUNES

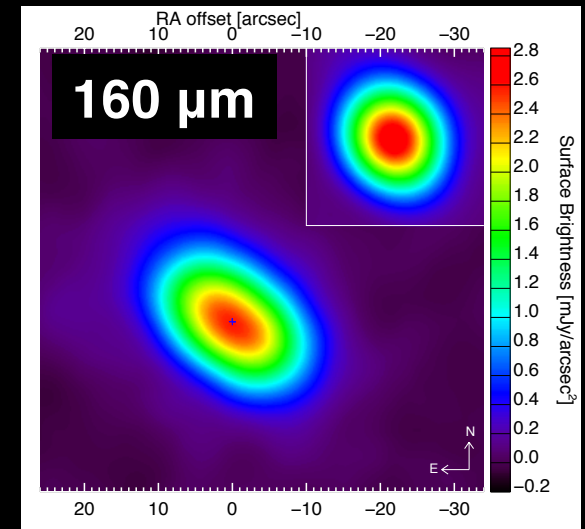
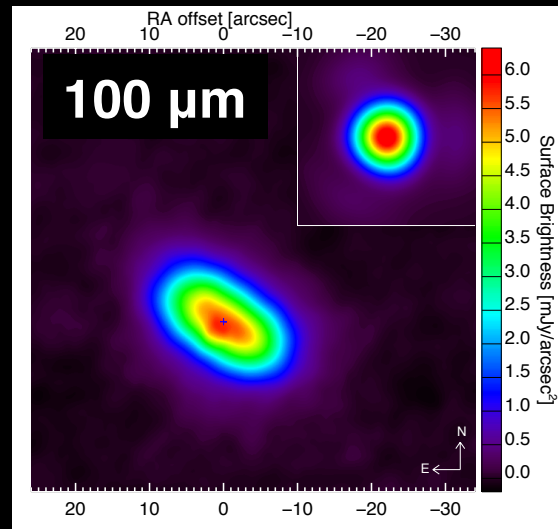
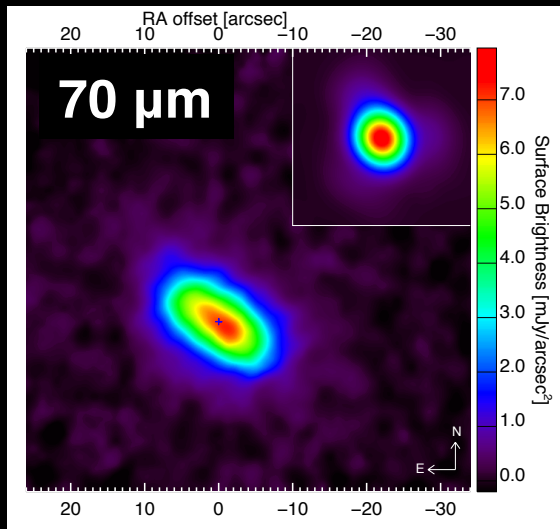
“Dust Around Nearby Stars”

PI: C. Eiroa (U. de Madrid)

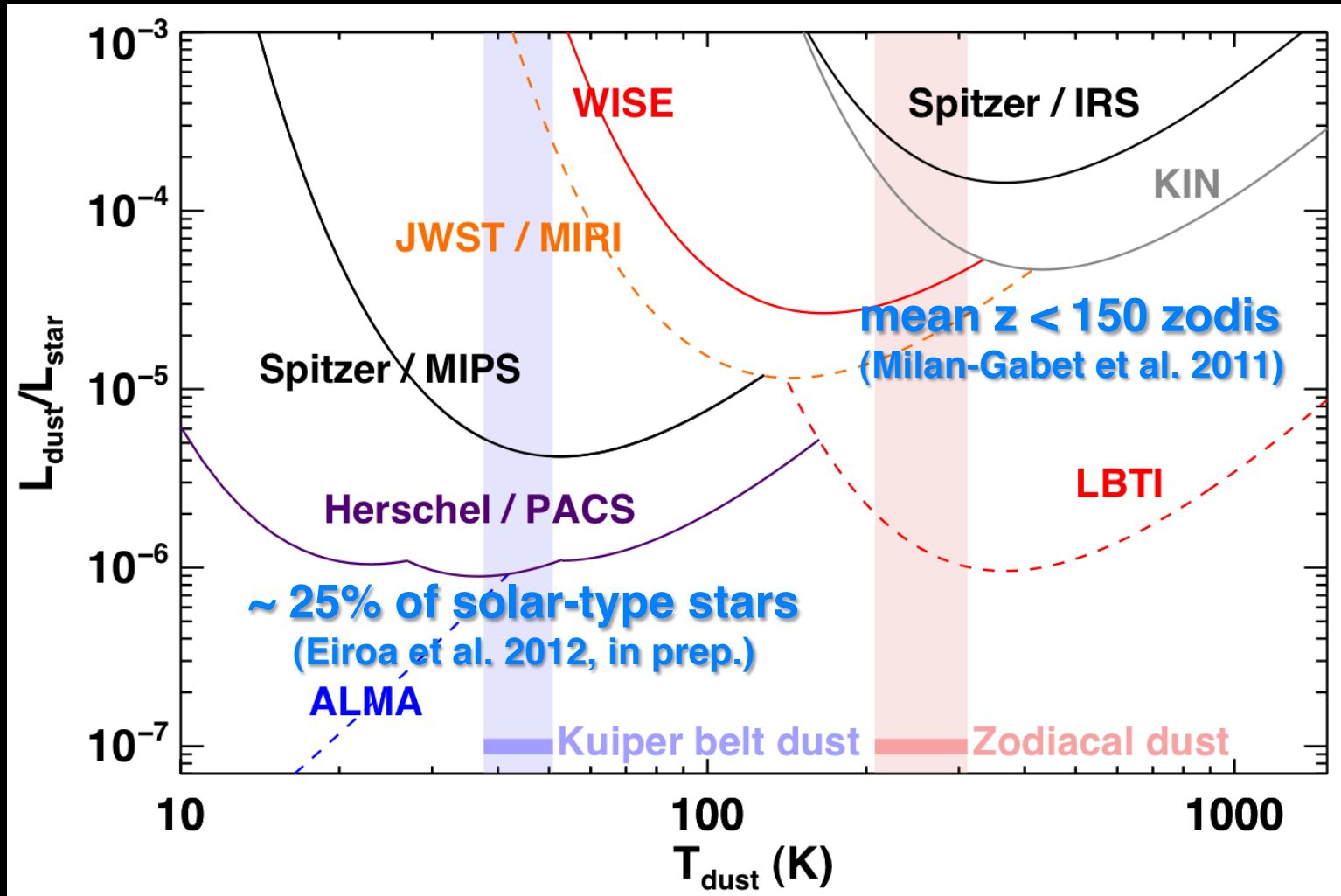
- 150 hours, far-IR imaging of 134 F, G, K stars
- With DEBRIS project, fairly complete survey of nearby solar-type stars ($d < 20$ pc) for cold debris dust

q1 Eri

Liseau et al. (2010)

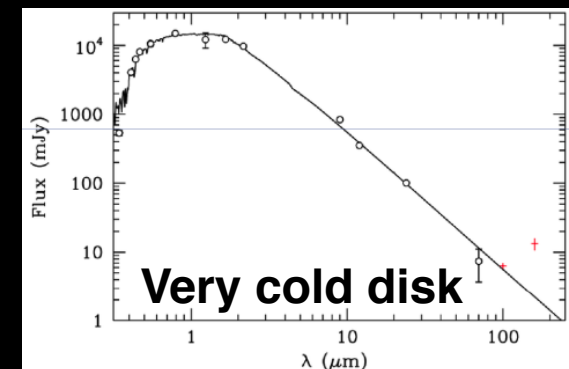
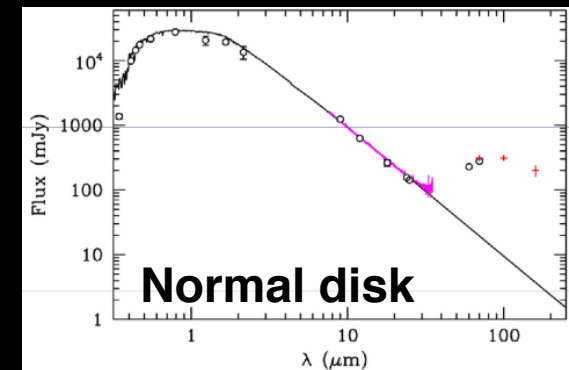
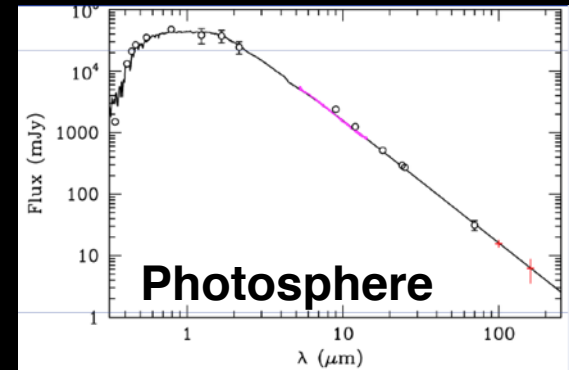


DUNES Survey Sensitivity



Other DUNES Highlights

- All targets detected at 100 μm ; planned sensitivity achieved
- Nearly $\frac{1}{2}$ of disks **spatially resolved**
- Variety of spectral energy distributions seen
 - Photospheres, normal disks, faint disks, strange “steep” disks
 - New class of very cold disks defy modeling; **failed systems?**



Summary

- 1) Finally, resolving lots of disks in thermal emission
- 2) Detections of debris gas emission from more than just Beta Pic
- 3) Quarter of solar-type stars with $> 10x$ our Kuiper belt

