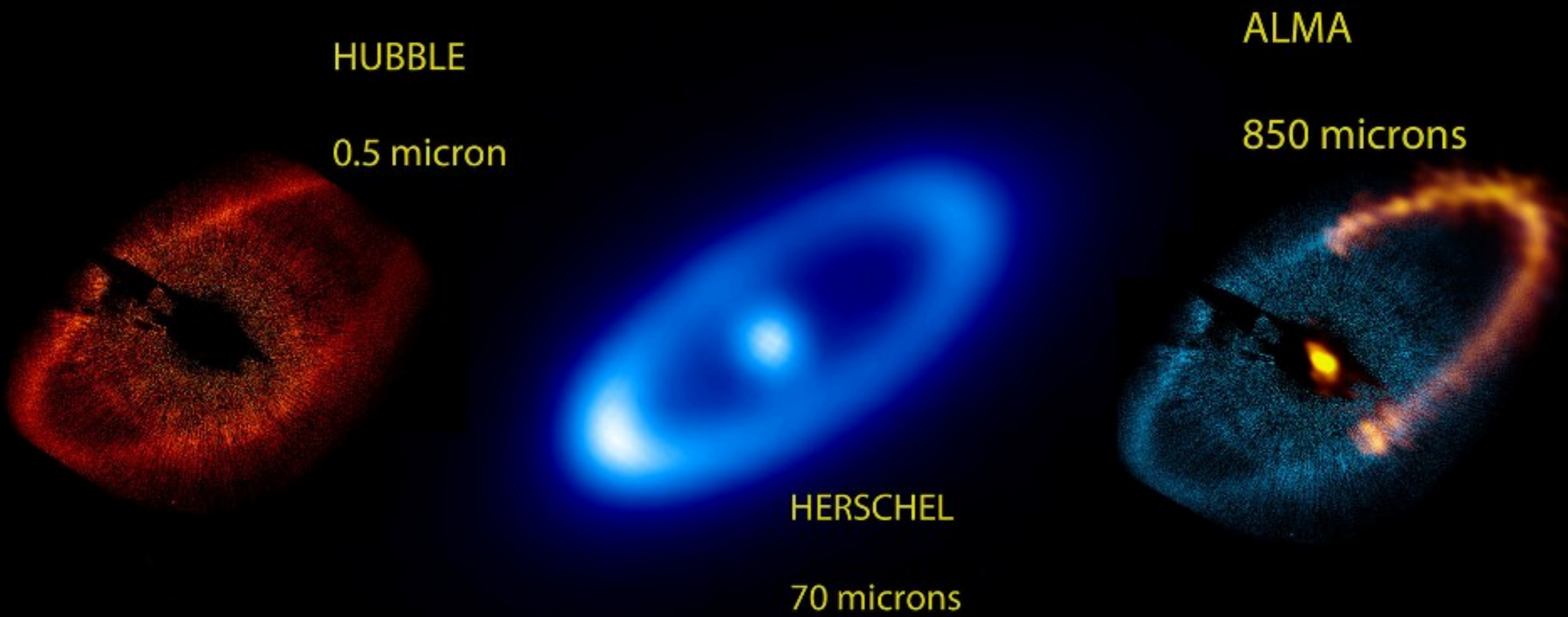
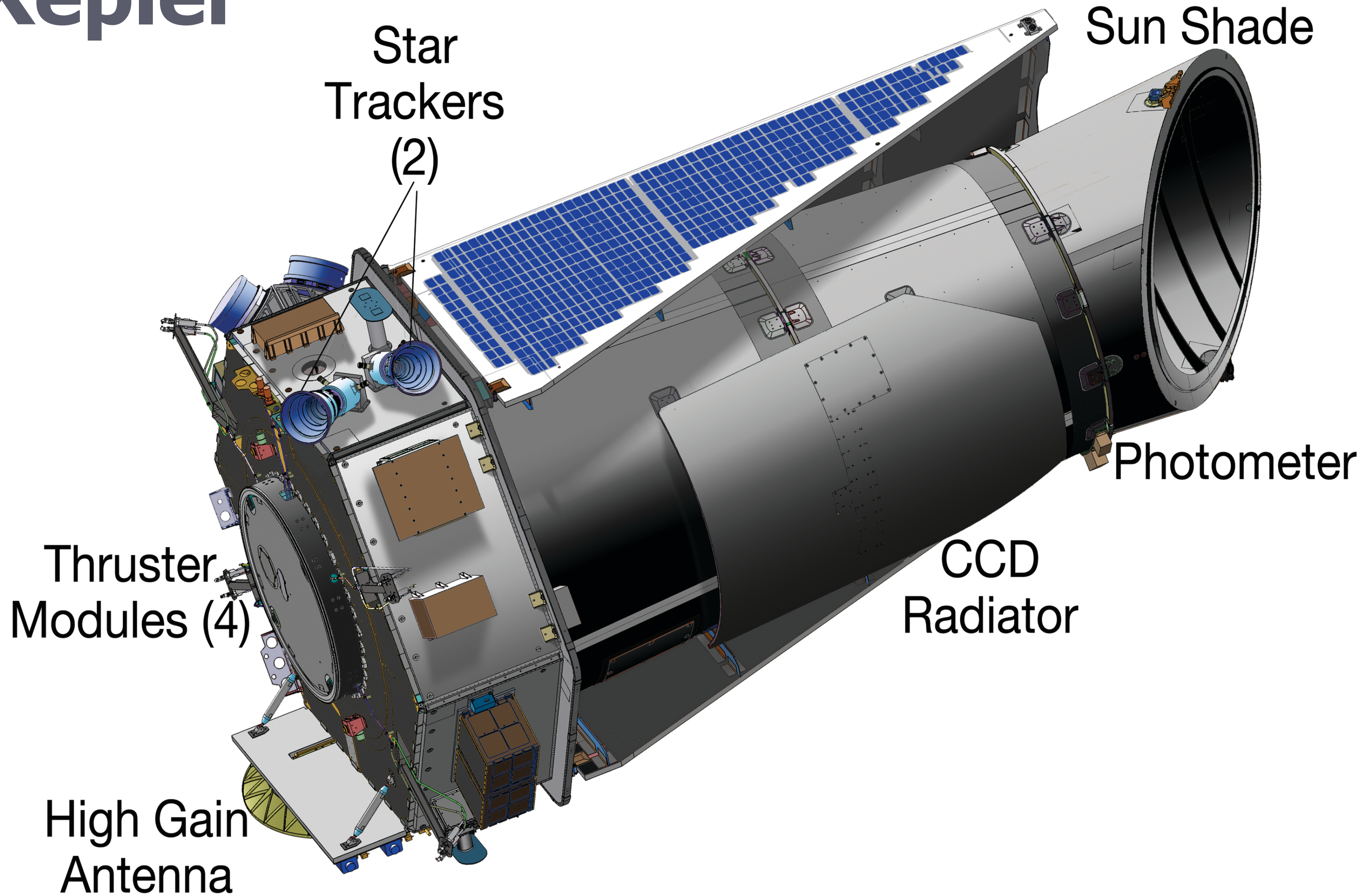
Herschel/PACS photometry of transiting-planet host-stars with candidate warm debris disks

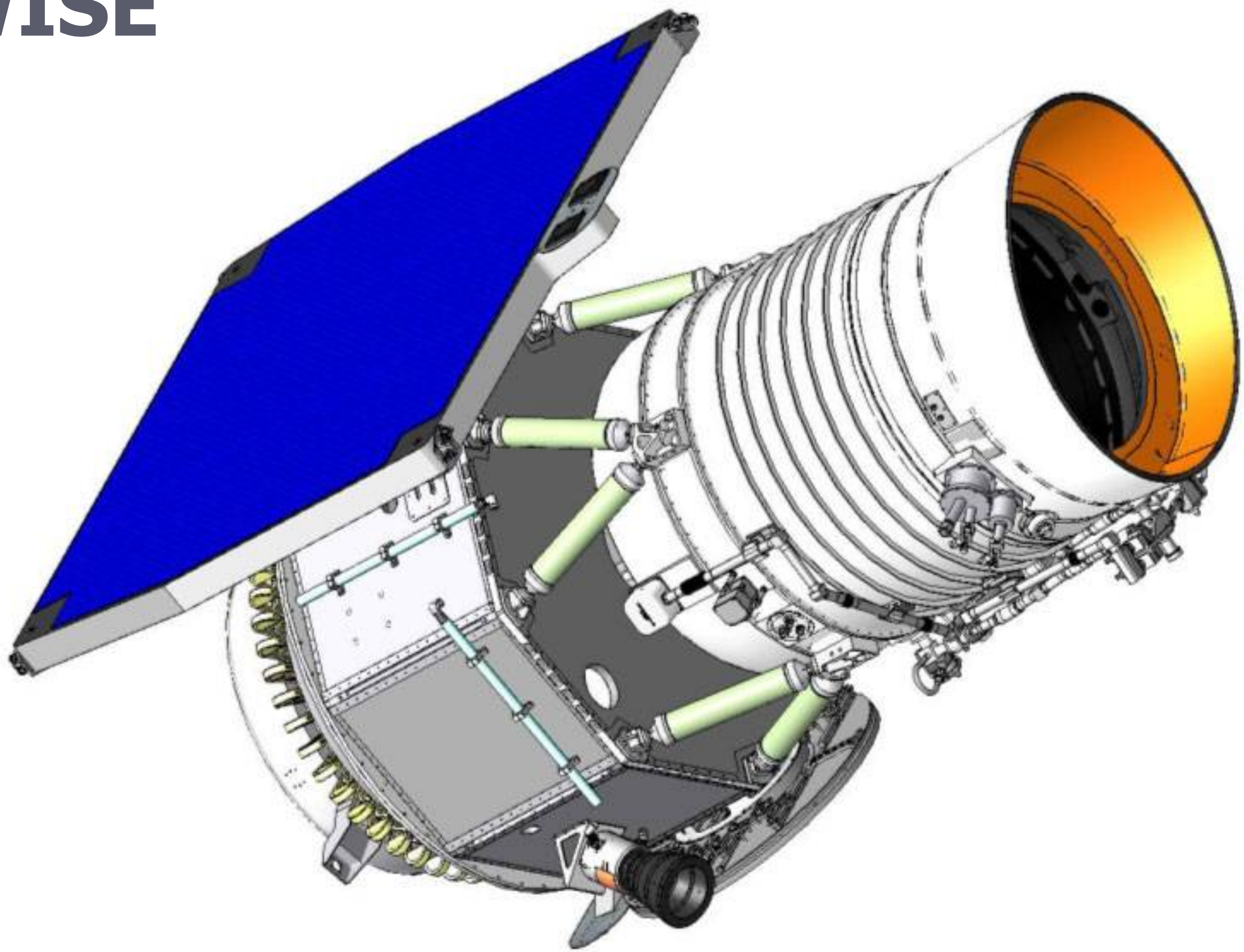


Bruno Merín (HSC-ESAC) @BrunoMerin,
David R. Ardila (NHSC-IPAC), Álvaro Ribas (CAB-ESAC), Hervé Bouy (CAB-ESAC),
Geoffrey Bryden (JPL), Karl Stapelfeldt (Goddard), Deborah Padgett (SSC)

Kepler

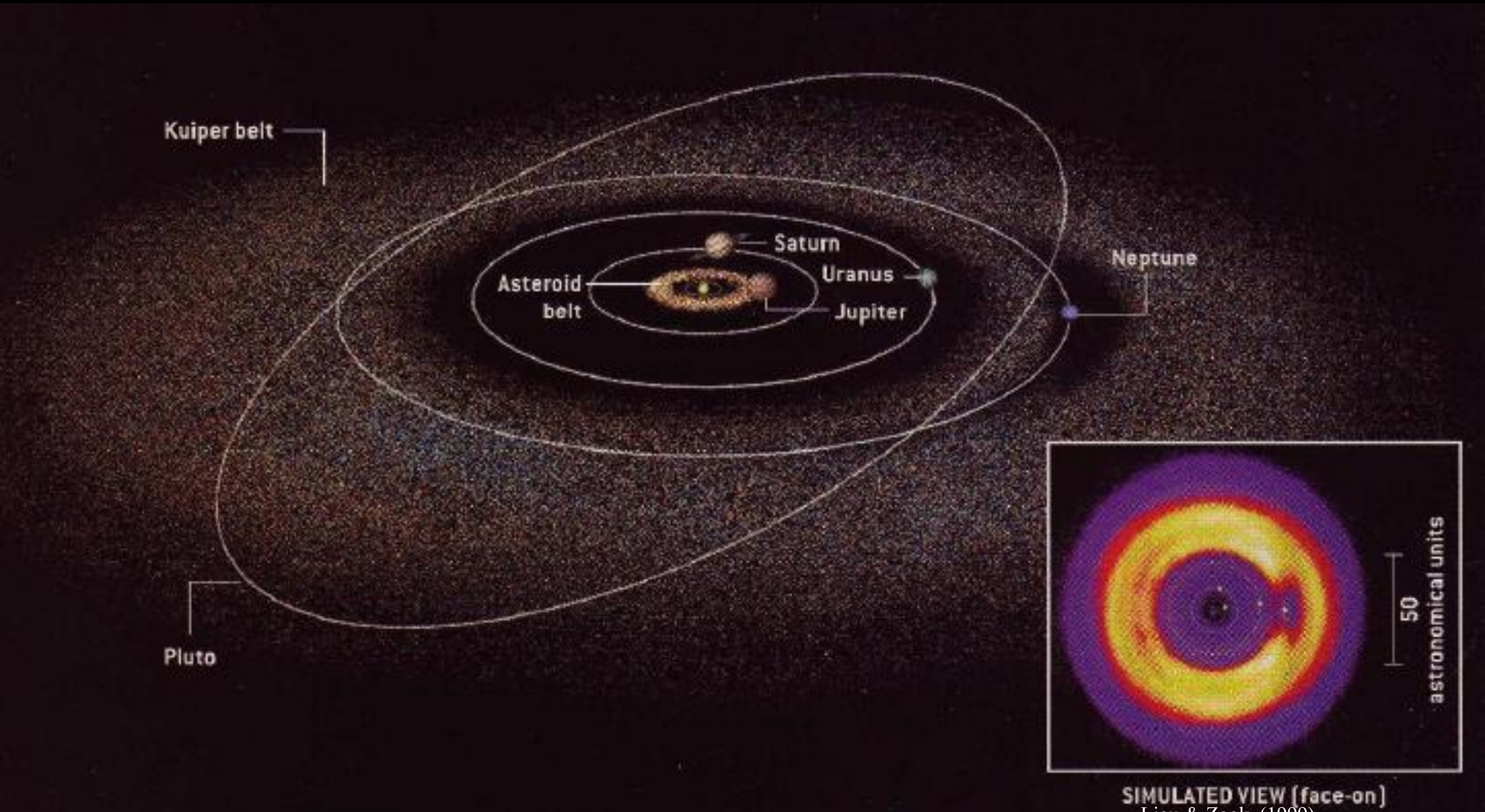

Star Trackers (2)
Sun Shade
Photometer
CCD Radiator
Thruster Modules (4)
High Gain Antenna

WISE



Herschel

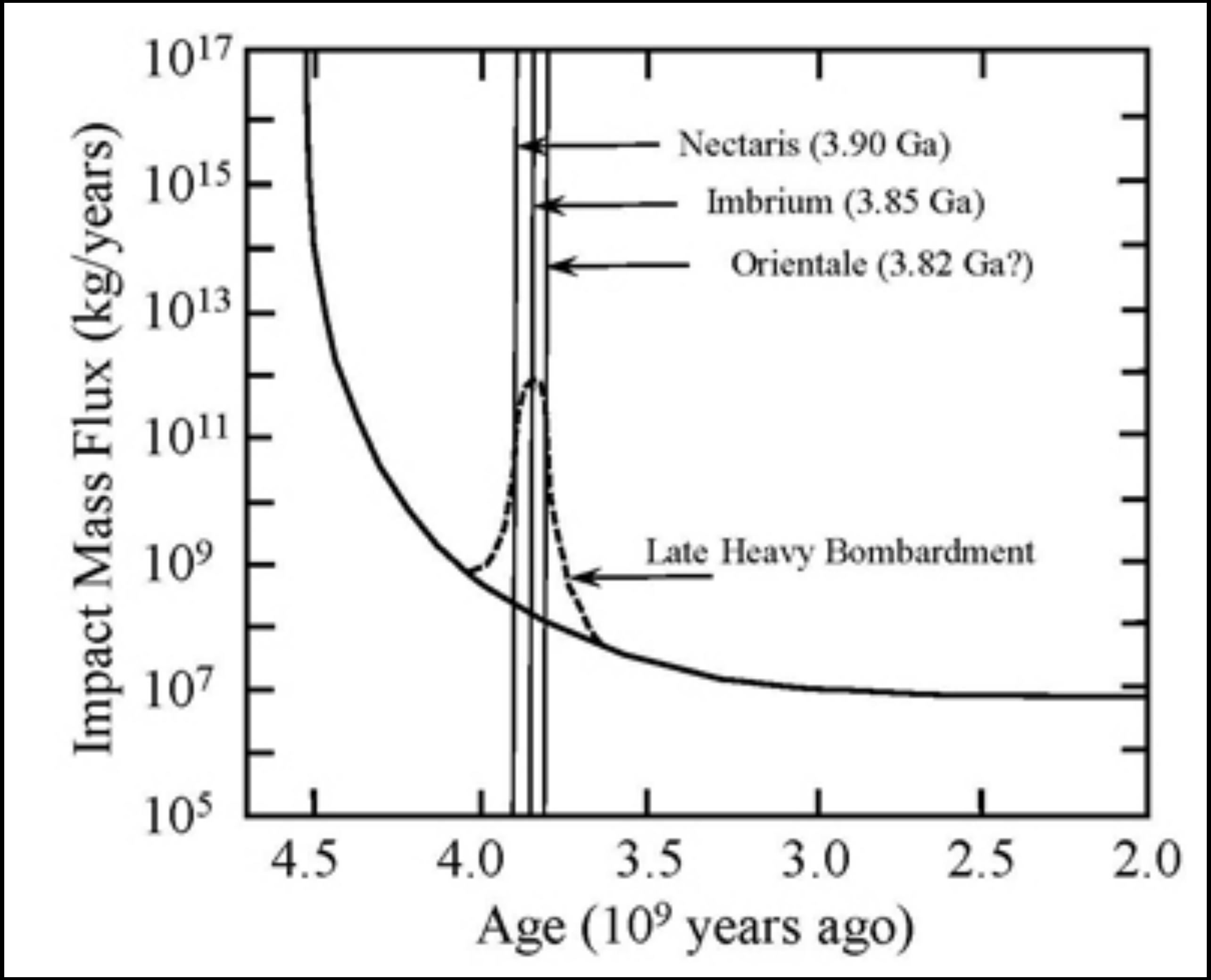
A planetary system is much more than planets…

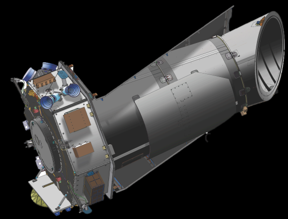


Liou & Zook (1999)

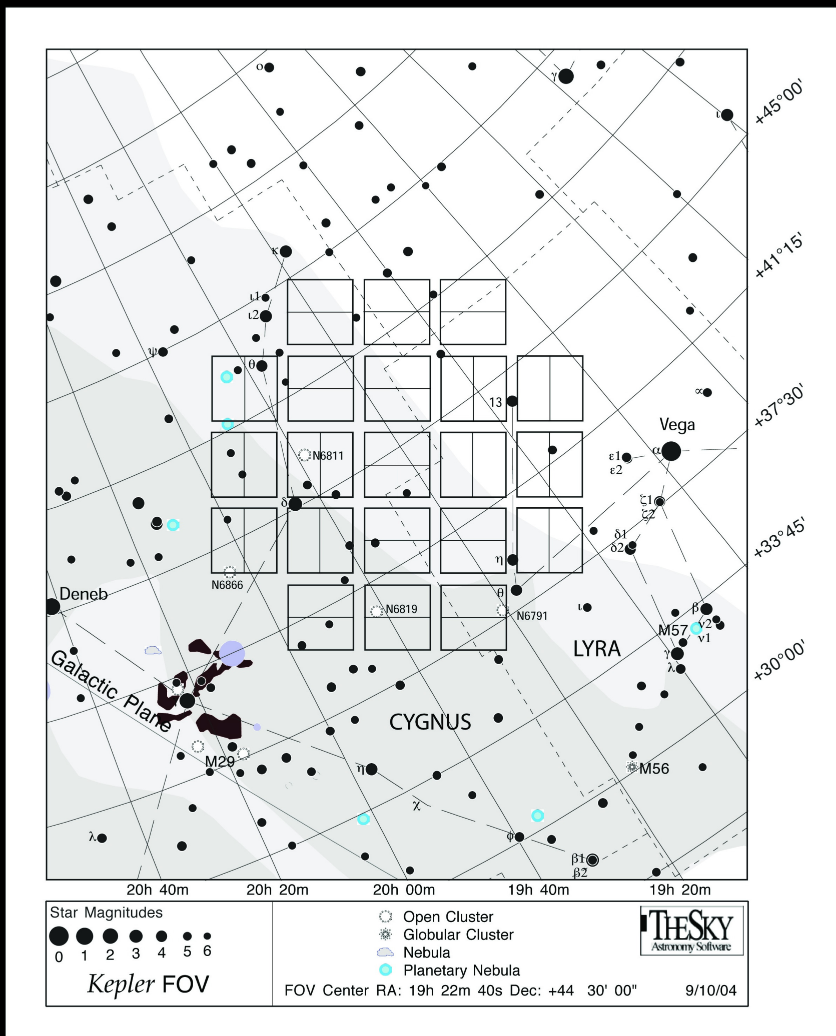

Press Esc to exit full screen mode.
0:19/0:20

Quiet after the Late Heavy Bombardment





The Kepler Spacecraft

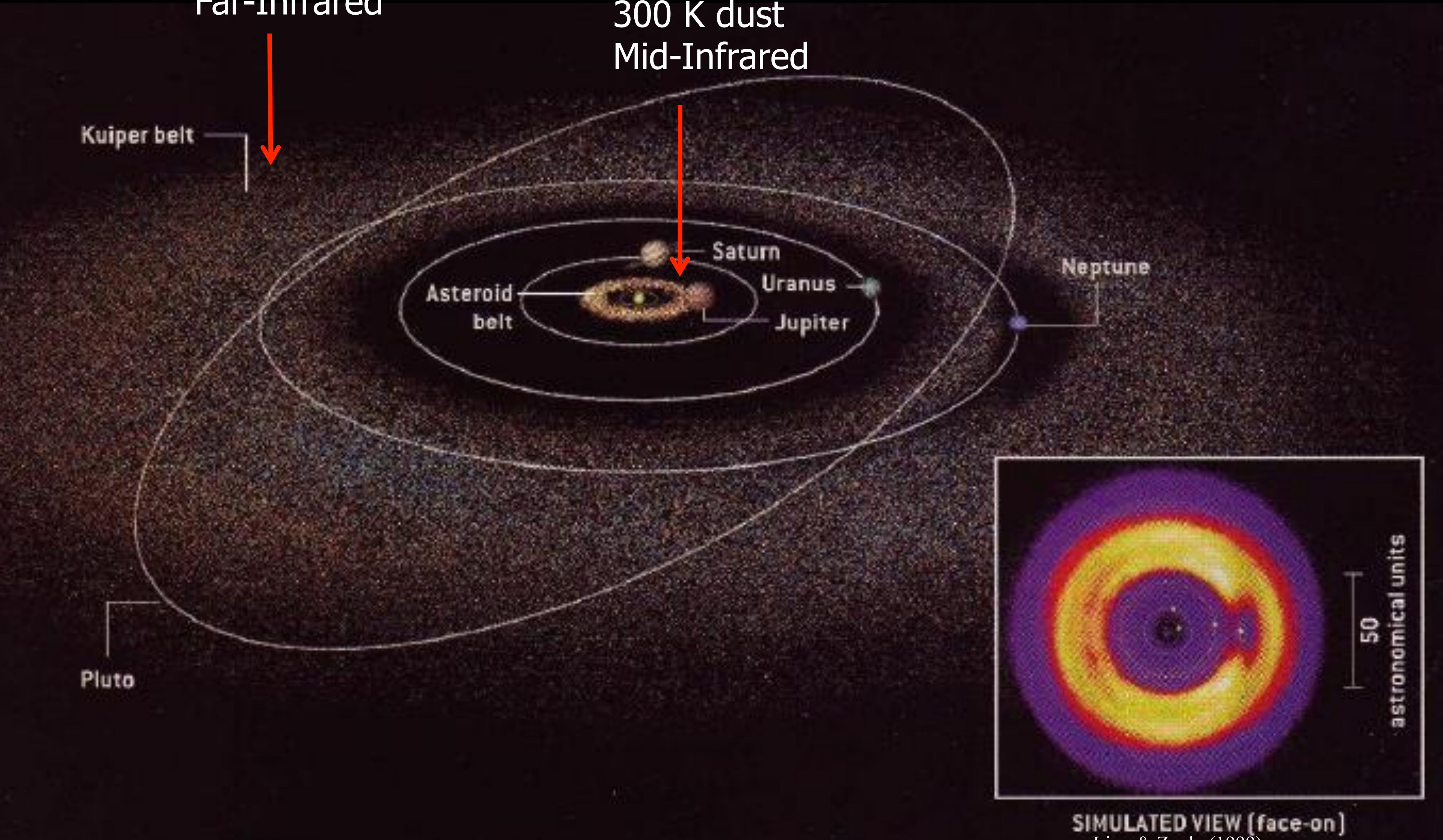


- Launched on March 2009; Ø=0.95 m optical, staring at >150K "solar-type" stars
- Transit detections: Measures planet radii, orbit axes
- So far: 4633 planet candidates; 1019 confirmed.
- COROT: Convection, ROtation and planetary Transits. Launched on 2006; Ø=0.27 m; 6K-12K stars. 401 candidates; 26 confirmed


LIKE
LATER
SHARE
EMBED
SCALING IS ON
Jupiter
Press Esc to exit full screen mode.
Mercury
Mars
Earth
00:03
HD

50 K dust
Far-Infrared

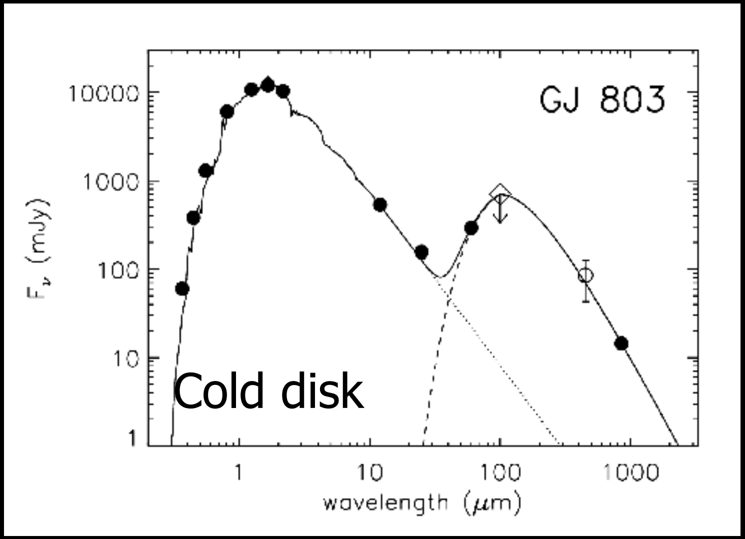
300 K dust
Mid-Infrared



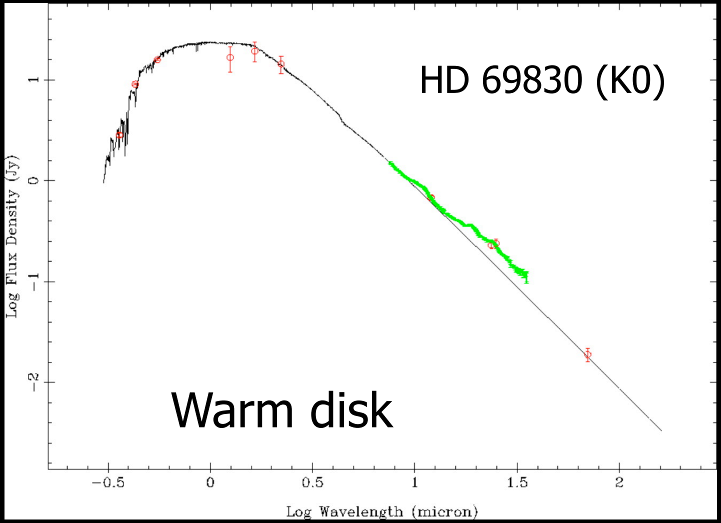
Liou & Zook (1999)

Most known debris disks are cold

- ISO/Spitzer/Herschel: ~15 - 20% of main sequence FGK stars have debris disks (Eiroa et al. 2013)
- No correlation with Radial Velocity (RV)planets (based on ~150 RV planets – Kóspál et al. 2009)
- ISO/Spitzer: only 4% of stars have excesses at 24 mic. Most are the Wien tail of the blackbody (Trilling et al. 2008)

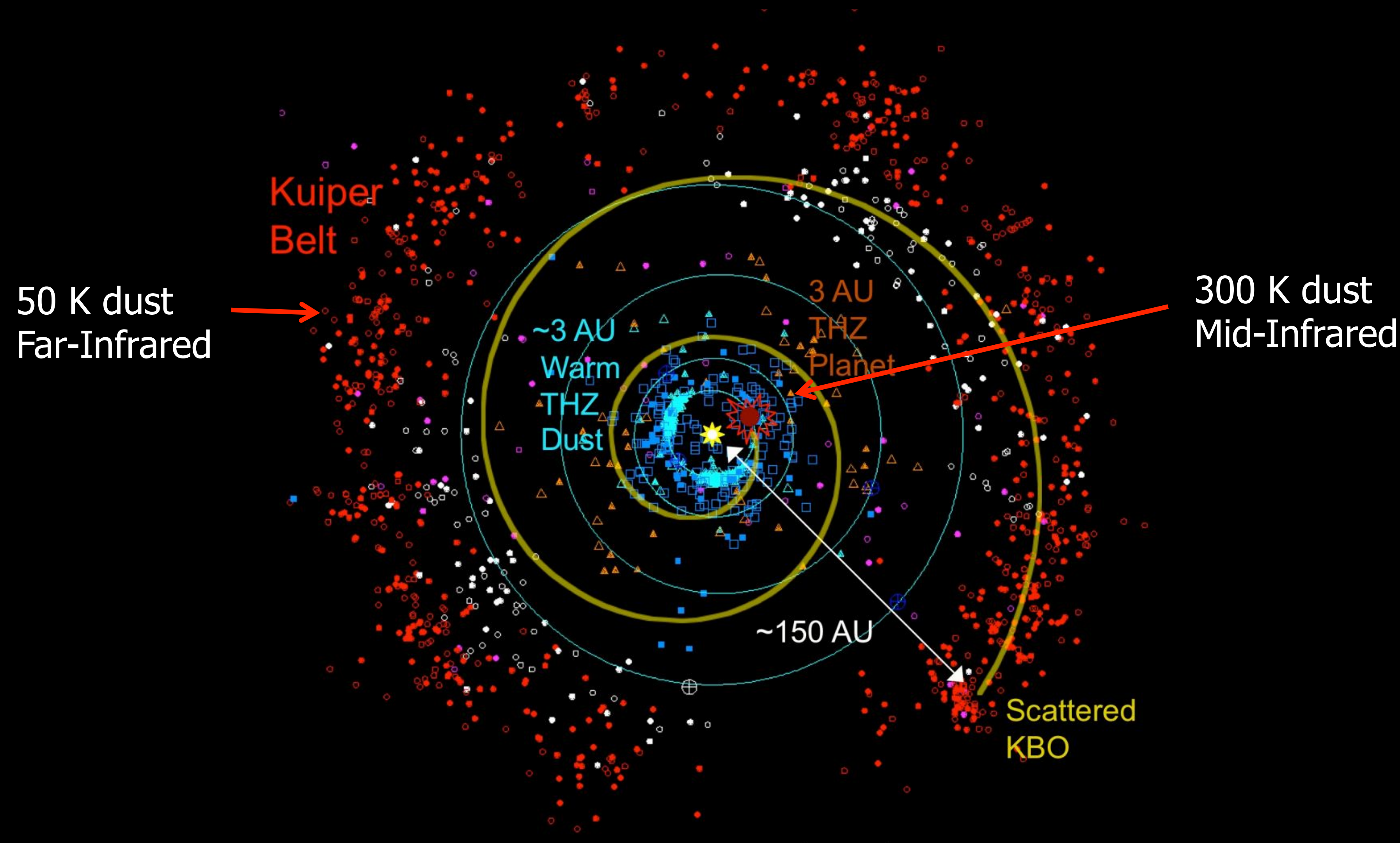


AU Mic (M0)
100 mic
↓
50 K
↓
31 AU
↓
to Neptune!



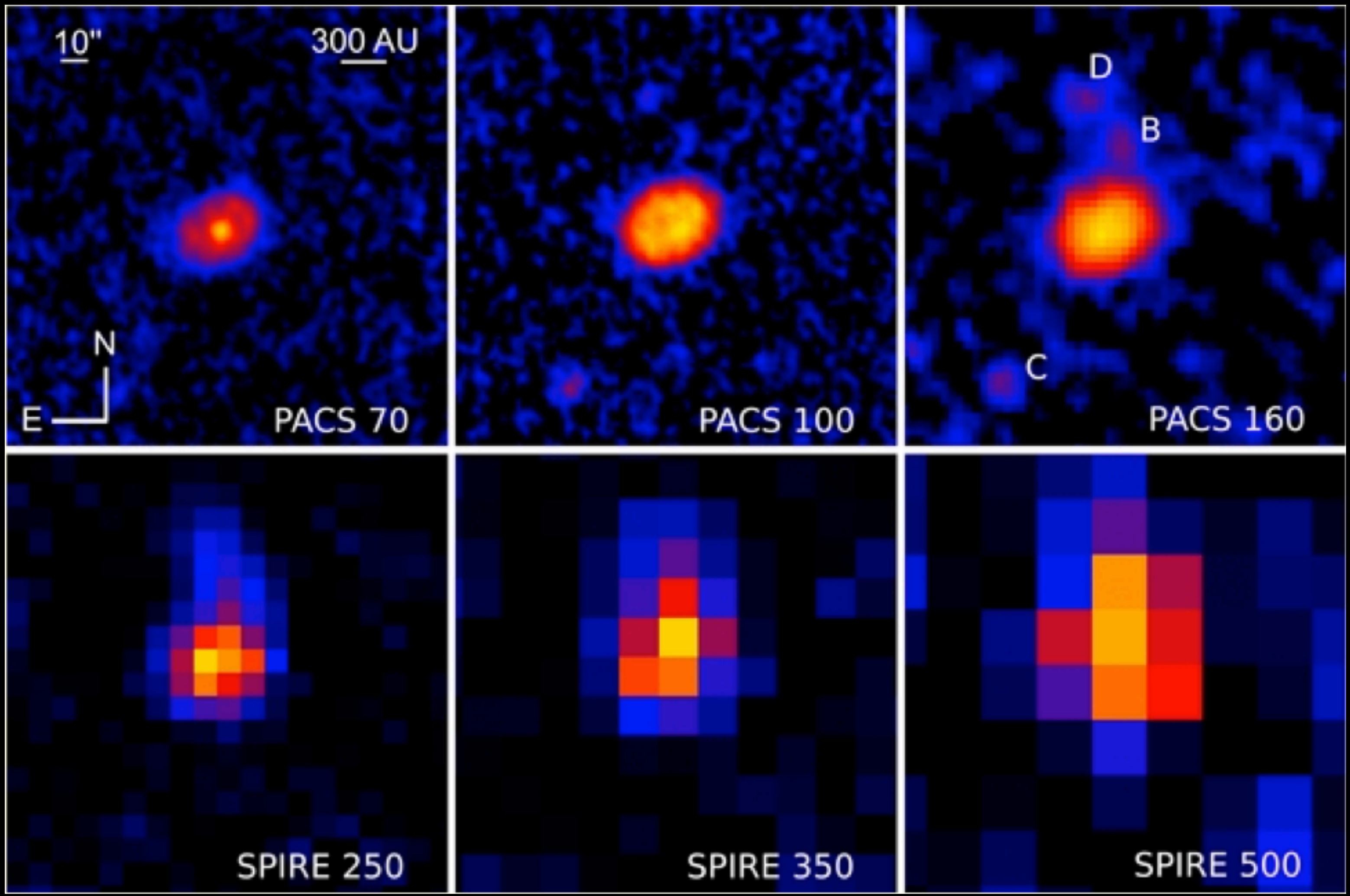
24 mic
↓
1 AU

Warm (mid-IR) excesses likely imply shocks



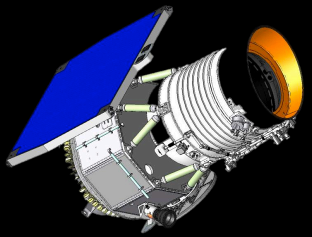
Warm debris disk model for nearby star η Crv (Lisse et al. 2012)

Warm (mid-IR) excesses are also detectable at Far-IR



Herschel PACS/SPIRE imaging of η Crv Duchêne et al. (2014)

The Wide-field Infrared Survey Explorer (WISE)

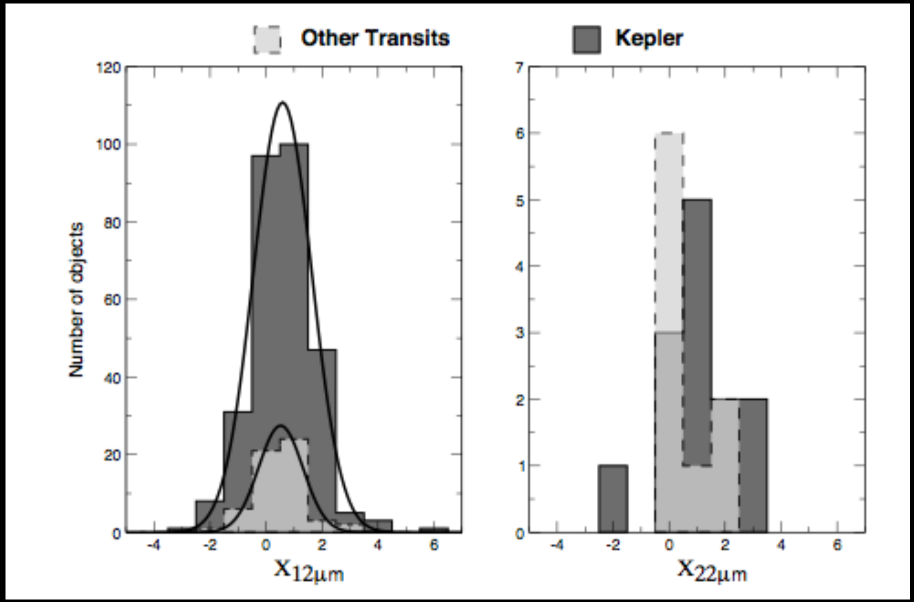


- Launched in Dec. 2009; 0.40 m telescope
- All Sky Survey at 3.4, 4.6, 12, and 22 microns
- Full all-sky **catalog** covers the full Kepler field
- 844 matches between Kepler, known transiting planets, and WISE sources.

Selection of mid-IR excess stars

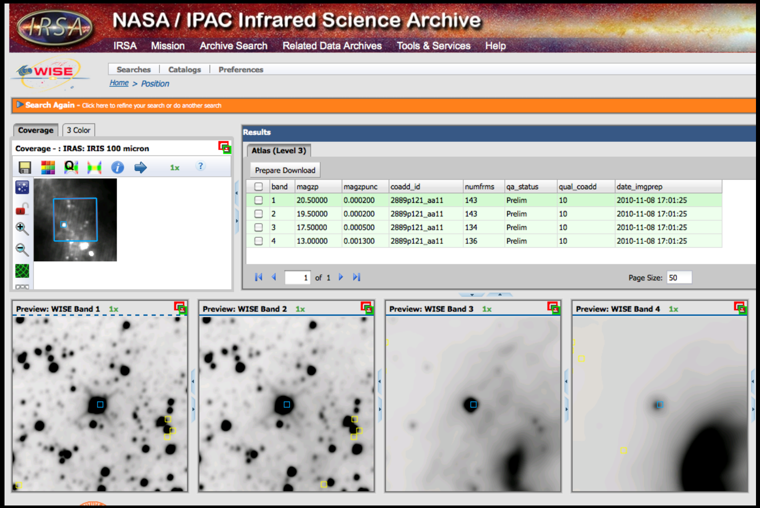
- We define the excess significance $X_{12/22}$ as:

$$X_{12,22} = \frac{(F_{12,22} - F_{12,22}^{phot})}{\sigma_{12,22}}$$

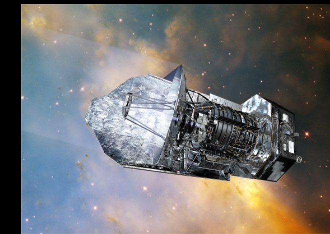


- And identify 293 with 2-σ excesses at 12 or 22 µm

- After WISE image inspection and quality control, we end up with 19 final targets



Confusion dominates



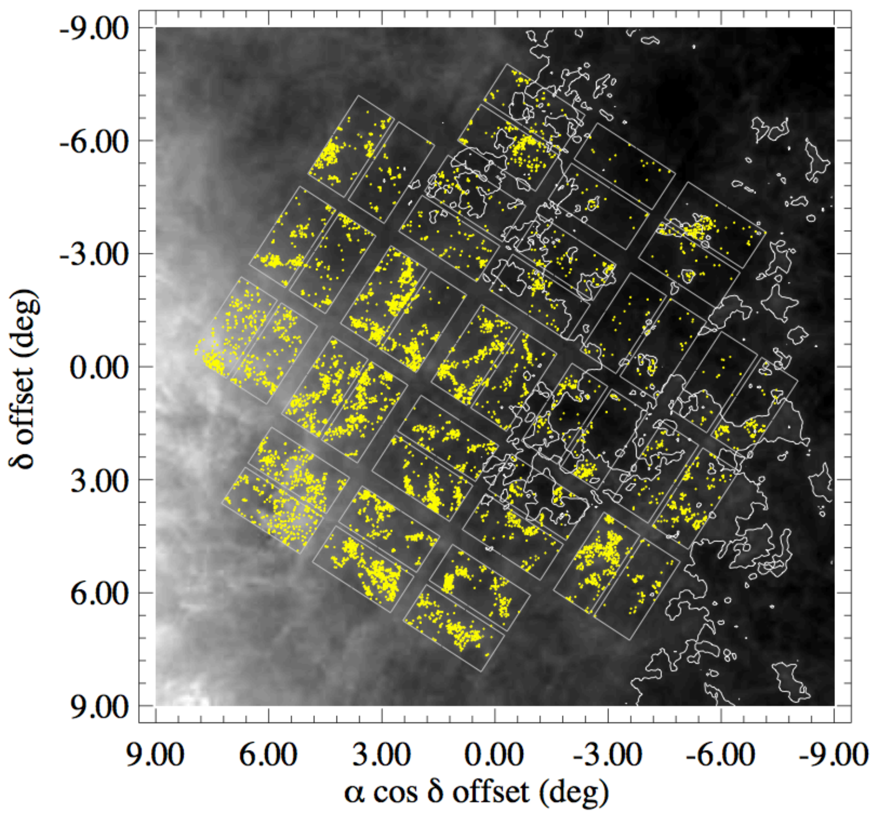
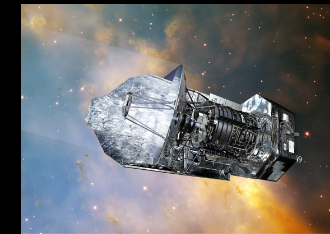


Figure 9. Clumping of stars with W3 excesses (yellow dots) indicating that the excesses are due to the high background level. The 5MJy/sr cut based on the IRAS 100μm background image is shown by the white contours.

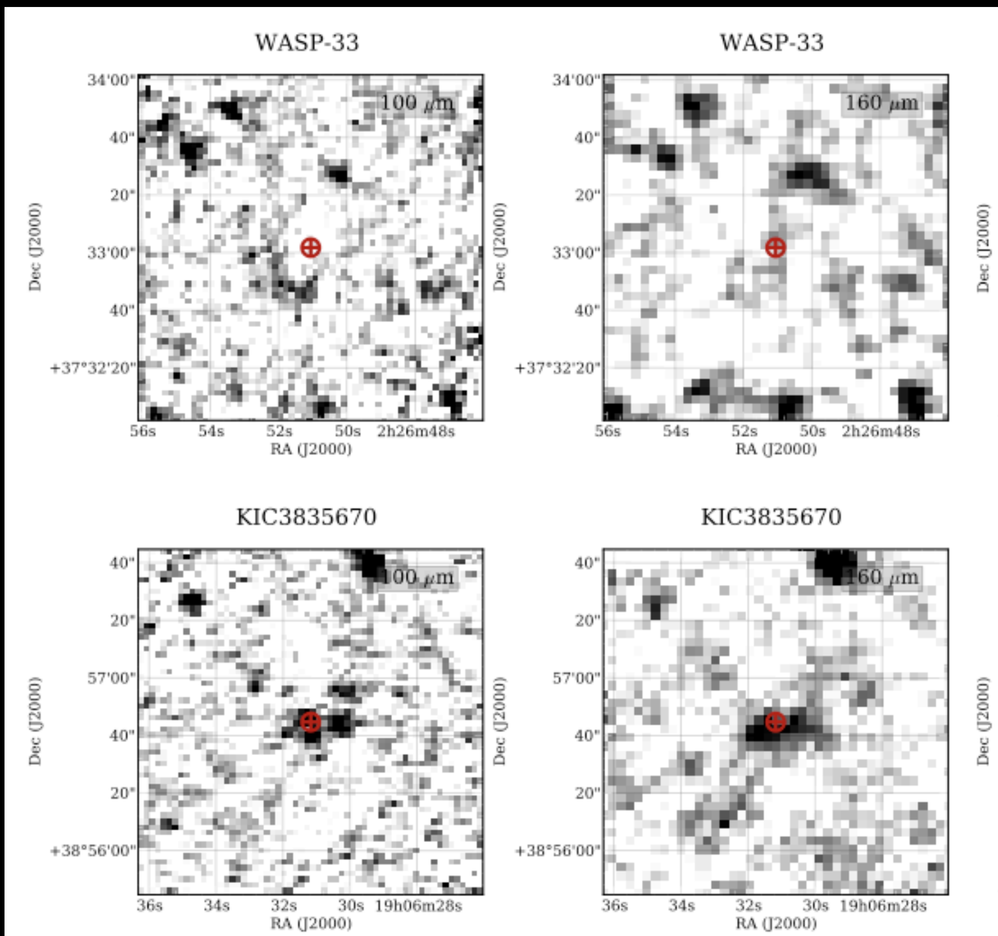
The frequency of sources can be explained statistically as contamination with background sources (either galactic cirrus or extragalactic sources)

Kennedy & Wyatt (2012)

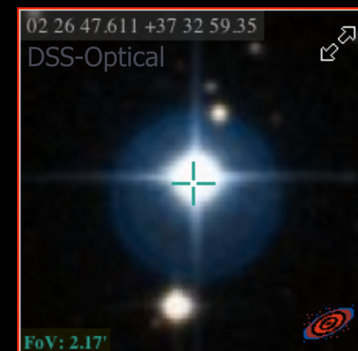
Follow-up in the Far-Infrared



- Herschel proposal OT2_dardila_2: PACS mini-maps at 100 and 160 μm -> no detections were found



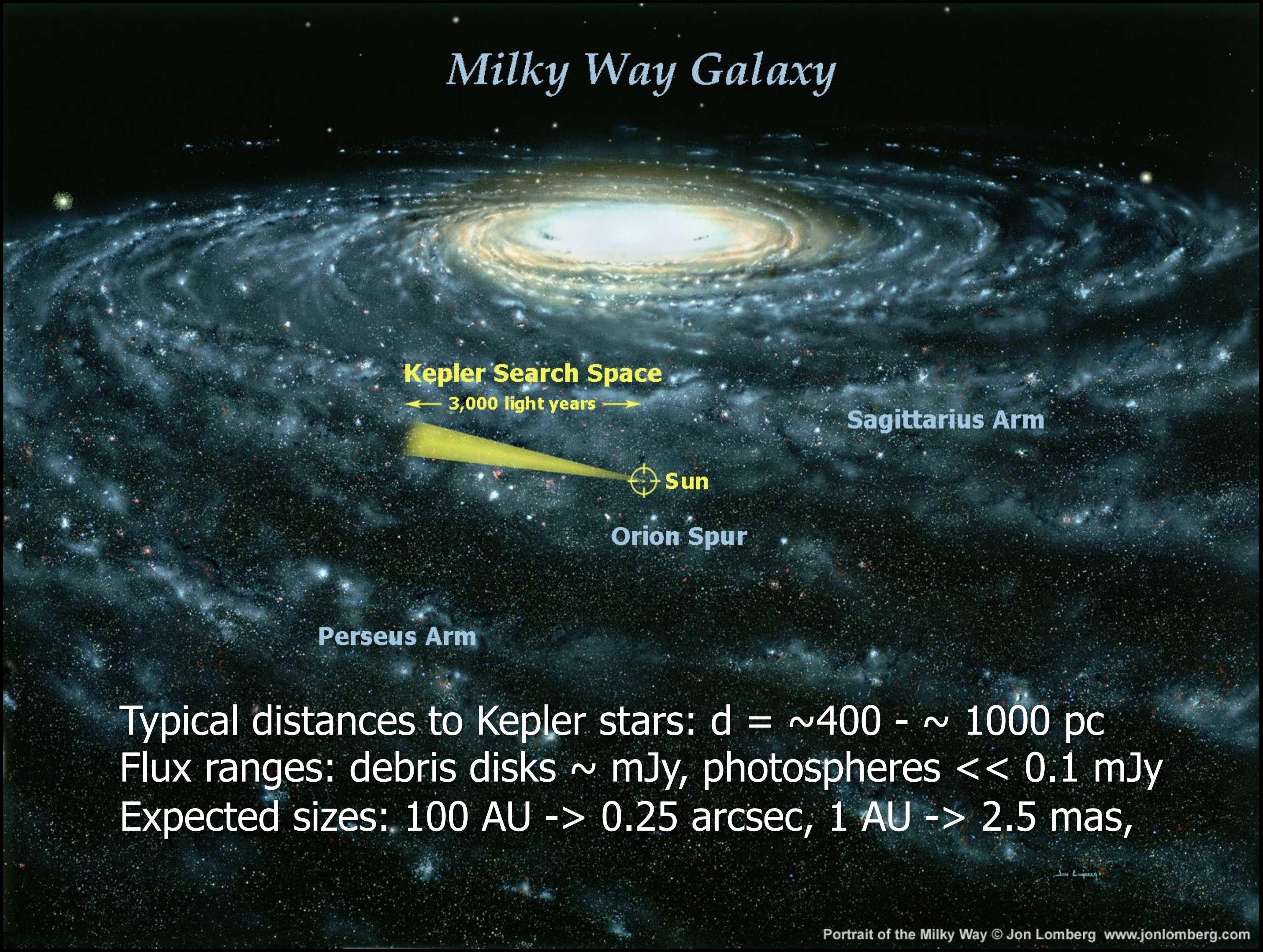
WASP-33



KIC 3835670

Merín et al. (2014)

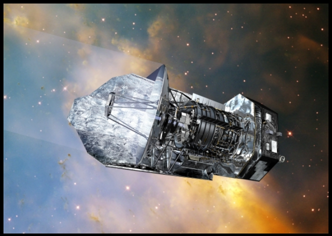
But all Kepler planet-host candidates are far



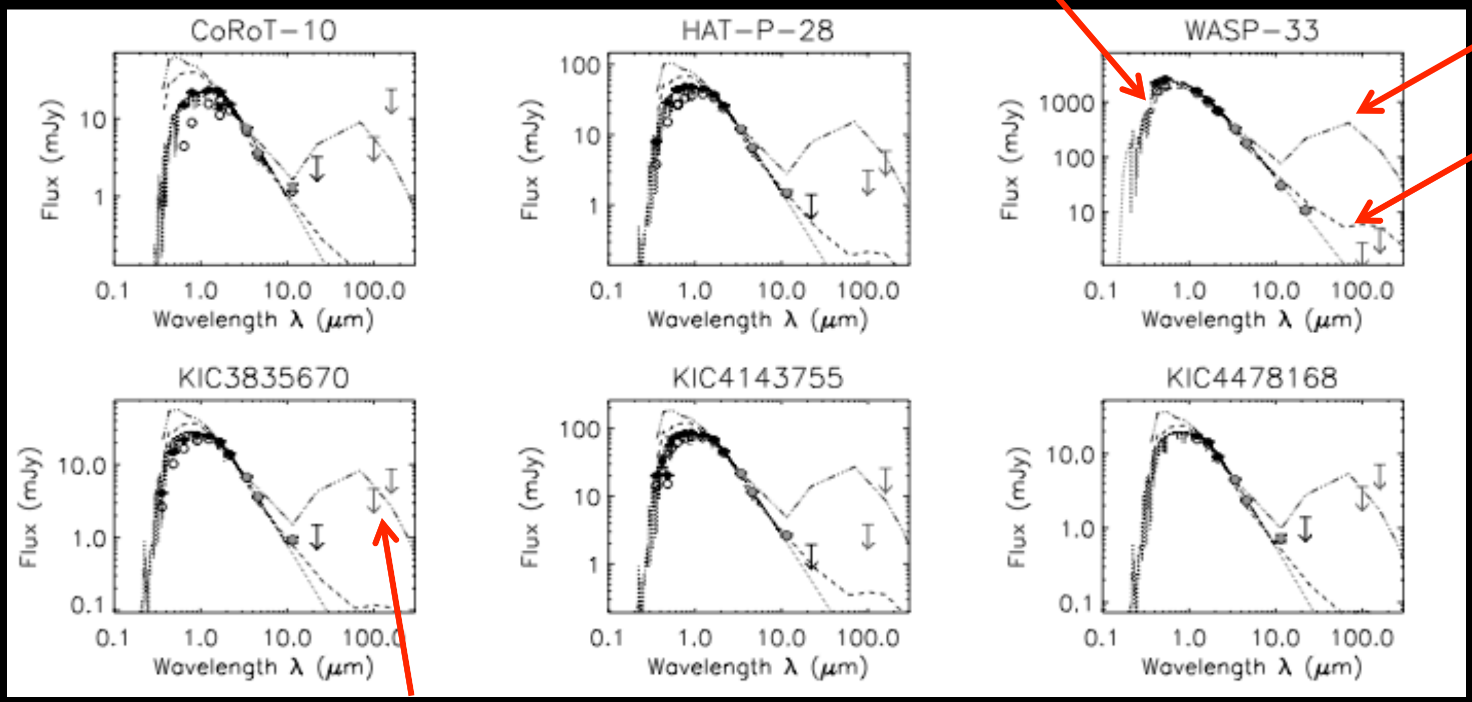
Typical distances to Kepler stars: d = ~400 - ~ 1000 pc
Flux ranges: debris disks ~ mJy, photospheres << 0.1 mJy
Expected sizes: 100 AU -> 0.25 arcsec, 1 AU -> 2.5 mas,

nasa.gov

Results

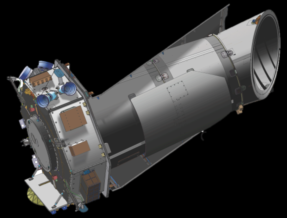


- No detections discard the possibility of large debris disks in most of the systems and leaves a small chance of just warm debris disks around them (in the planet's orbits).

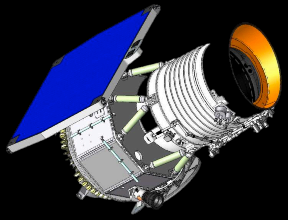


Merín et al. (2014)

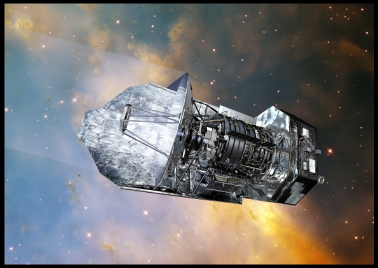
Conclusions from Herschel



- Kepler finds at least one exoplanet in close orbits per star in the Galaxy.



- WISE finds mid-infrared excesses in a small fraction of the star+exoplanet systems. If real they might imply catastrophic events.

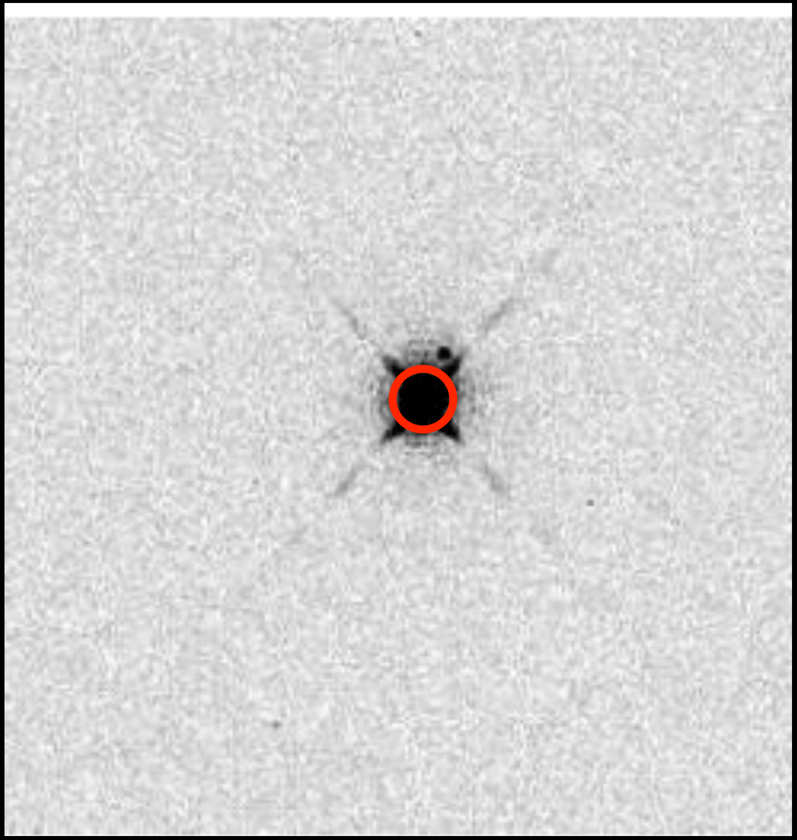


- Herschel finds no far-infrared emission and then suggests that mid-infrared excesses might be due to chance alignment of background sources (as already suggested by Kennedy & Wyatt 2012).

ALMA followup

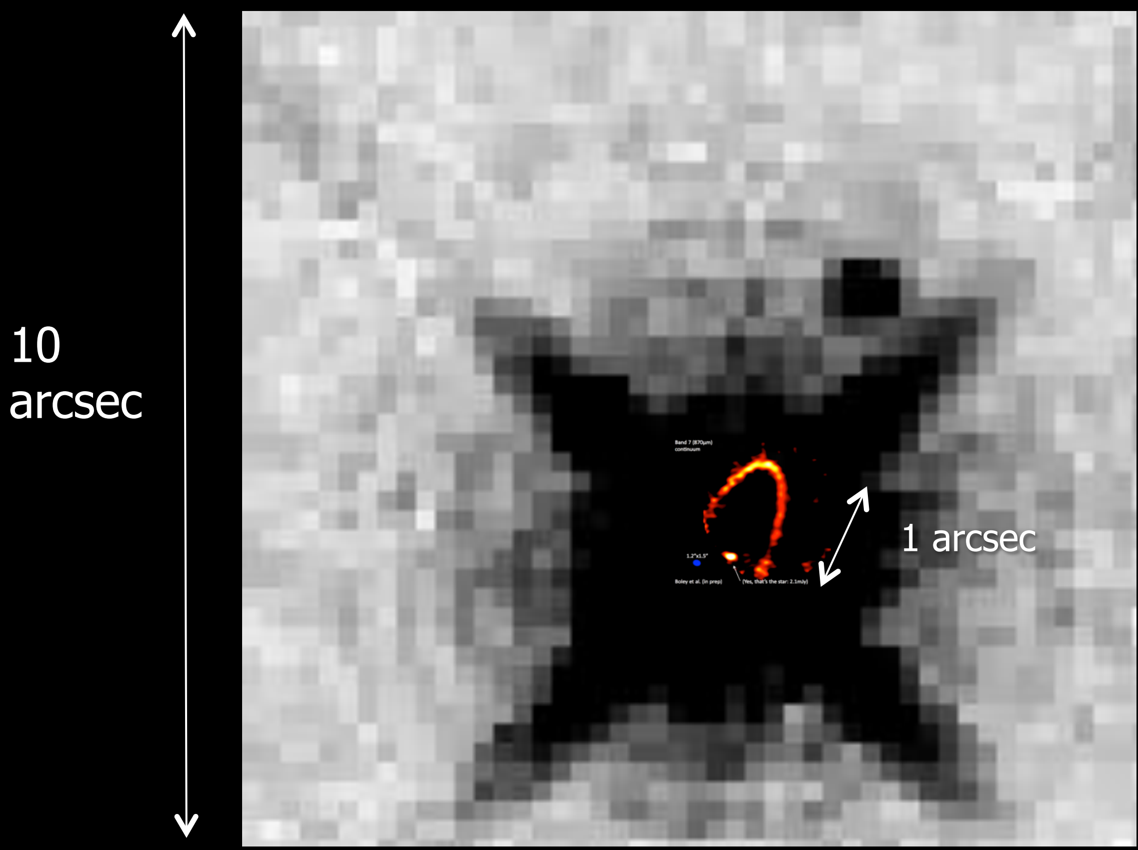
ALMA can help finding the contaminants or the disks

136 arcsec



HST WFC3/IR F139M

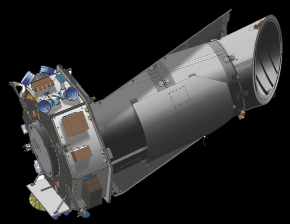
ALMA followup



HST WFC3/IR F139M

With ALMA's exquisite spatial resolution and sensitivity and the Infrared-selected potentially interesting targets, ALMA might help sorting out whether planet-hosting stars do also have faint cold debris disks or warm disks from collisions

Thanks!

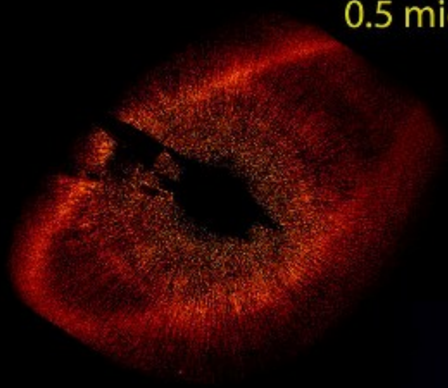


HUBBLE

0.5 micron

ALMA

850 microns



HERSCHEL

70 microns