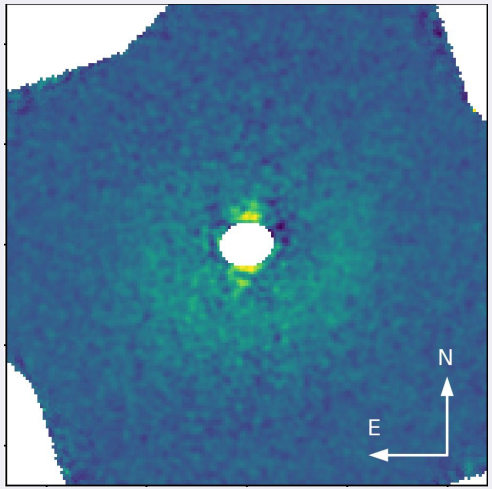
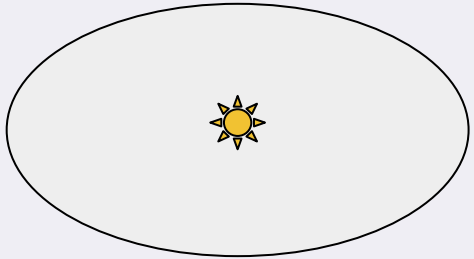
GPI Observations of a Resolved Low-Inclination Debris Disk Around HD 156623

Briley Lewis, UCLA
ExSoCal 2023

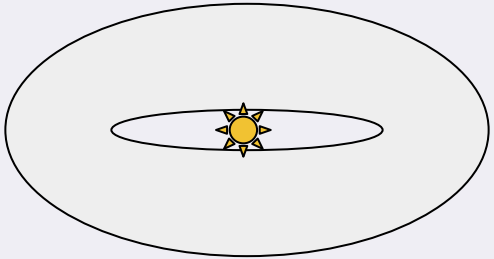


Debris disks, a.k.a. “Exo-Kuiper Belts”



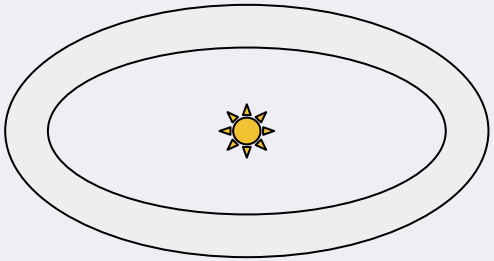
Protoplanetary/primordial disk — gas/dust, optically thick

~2-10 Myr



Transitional disk — gaps start forming

~1-2 Myr

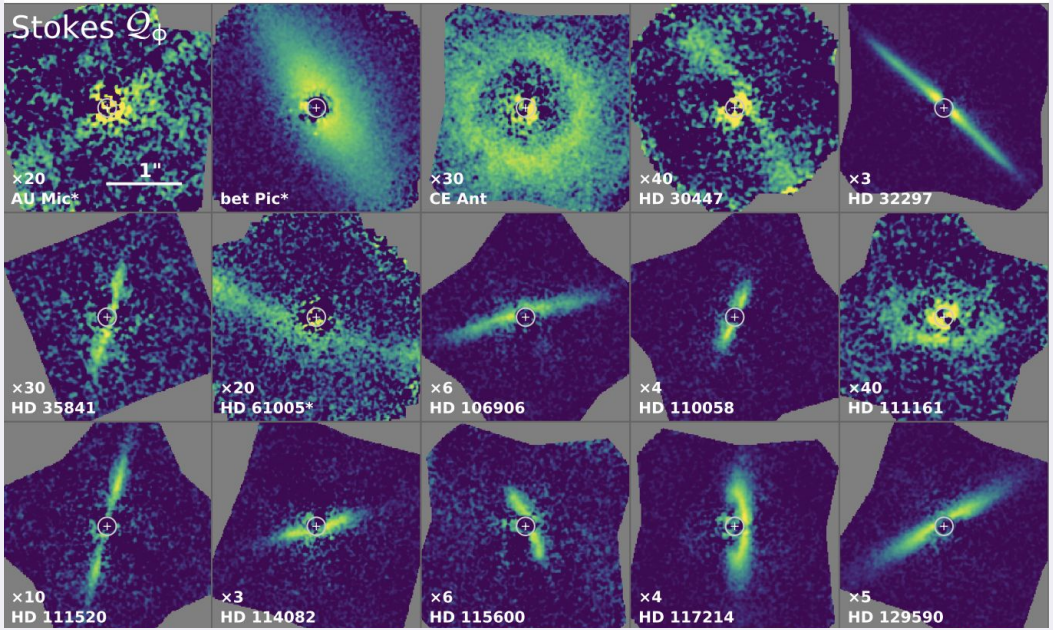


Debris disks — optically thin, mostly dust replenished by collisions

>5 Myr

Wyatt 2008

High-contrast imaging has resolved many examples



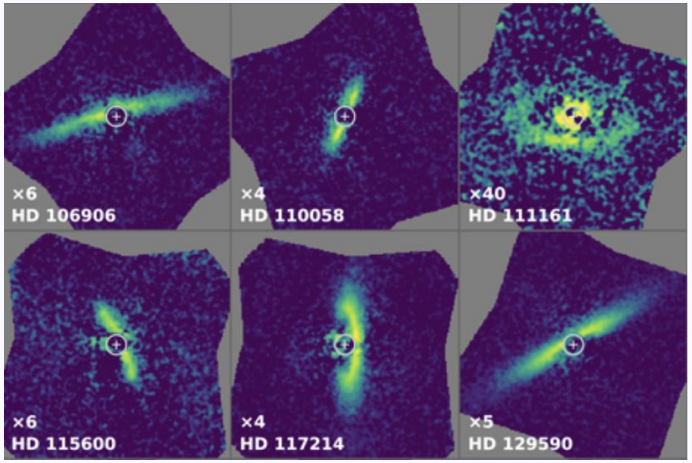
Gemini Planet Imager / Esposito et al. 2020

High-contrast imaging provides some key information for disks

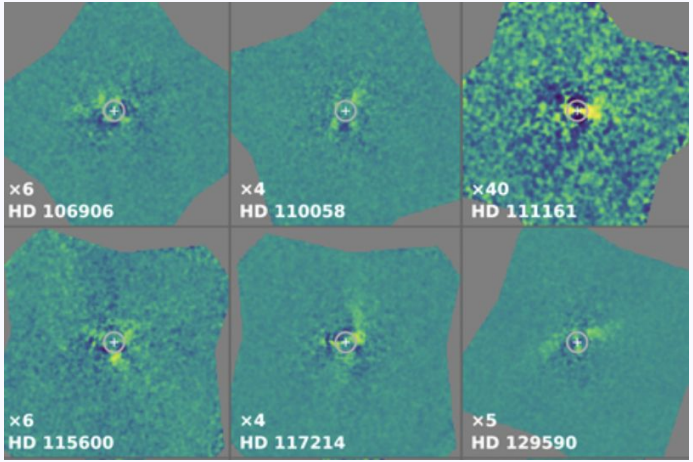
- Disk morphology and geometric parameters (i.e. warps, size, inner and outer radii) → Dynamical history, constraints on companions
- Scattering phase functions → Composition, grain size
- Polarized fraction and maximum polarization (if using polarimetry)

Polarimetric differential imaging (PDI) for debris disks

Q_ϕ

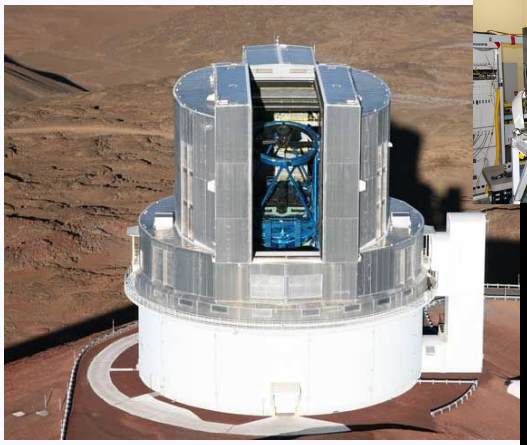


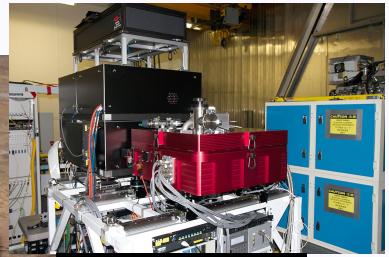
U_ϕ



Gemini Planet Imager / Esposito et al. 2020

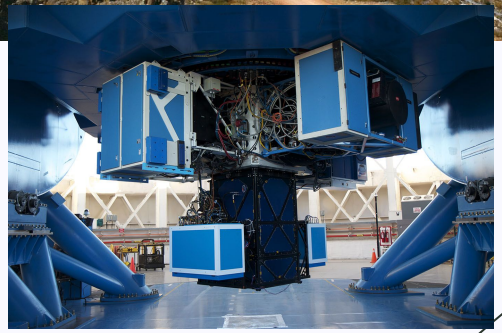
Current high-contrast polarimetric instruments





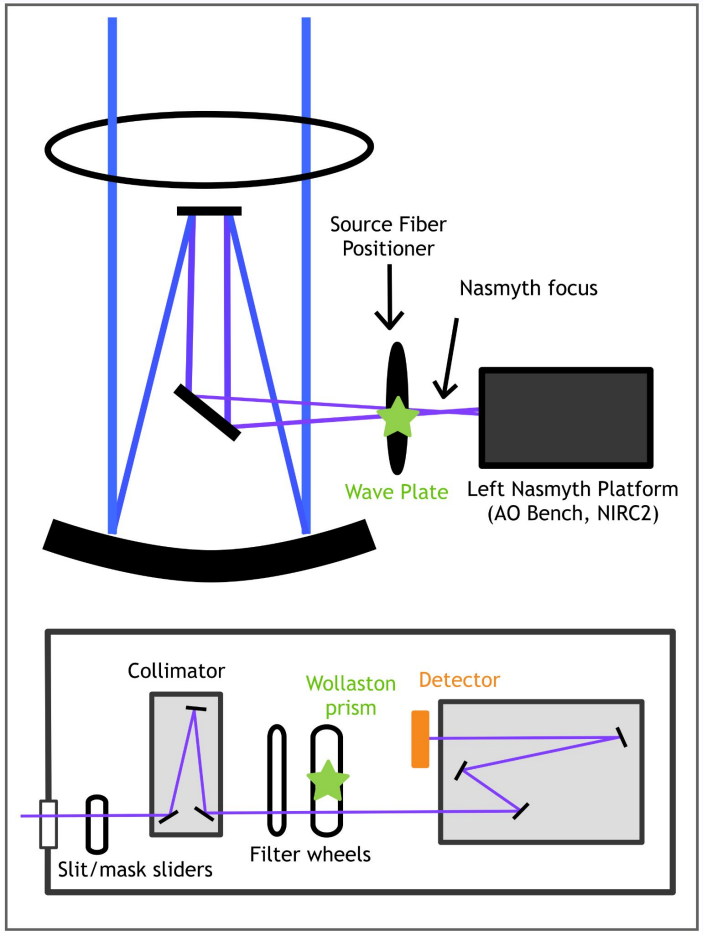
SCExAO
Subaru Coronagraphic Extreme Adaptive Optics

gpi
Exoplanet Survey



Future high-contrast polarimetric instruments

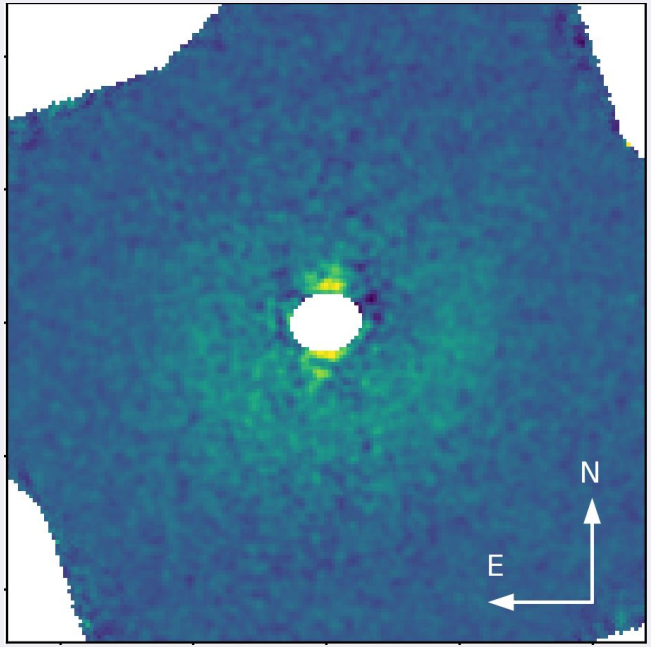
Keck NIRC2 Pol Mode!



Millar-Blanchaer et al. 2020

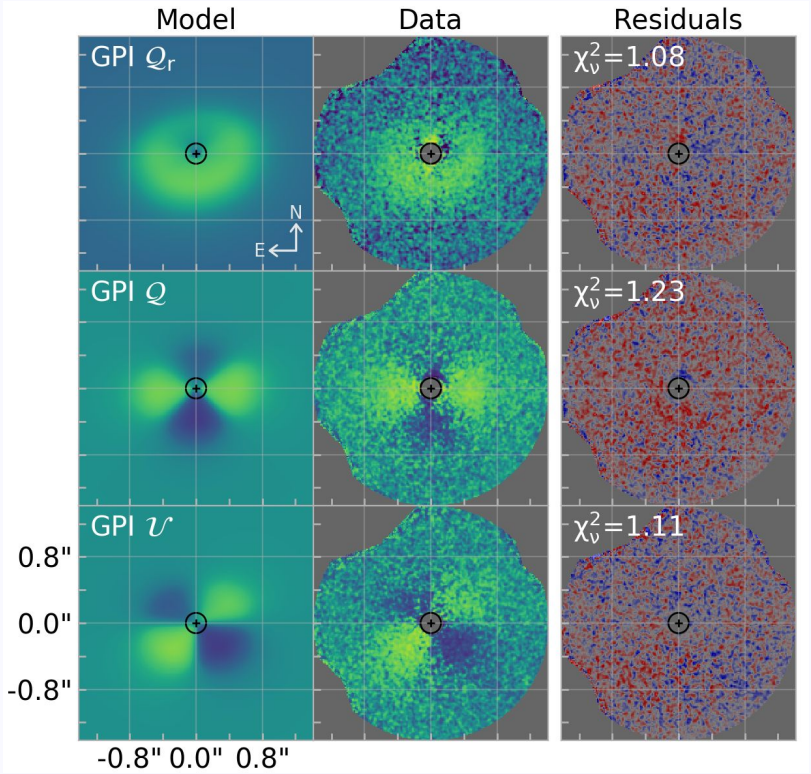
HD 156623's Unique Debris Disk

- The only debris disk in the GPI sample without a resolved inner clearing
- Known to host CO gas
- Big questions:
  - Where is the inner edge?
  - Is the gas primordial, or has it somehow been replenished?
  - Interplay between gas and dust?



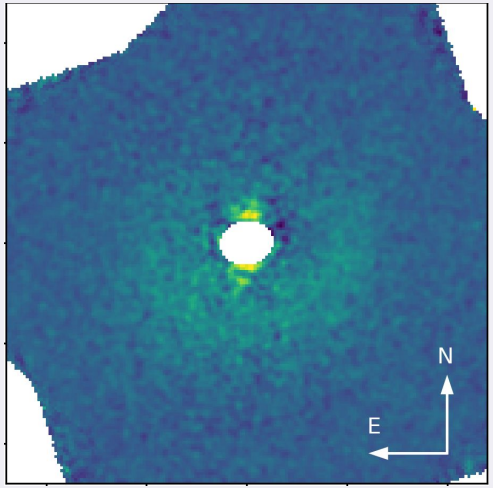
Esposito et al. 2020; Lewis et al. in prep

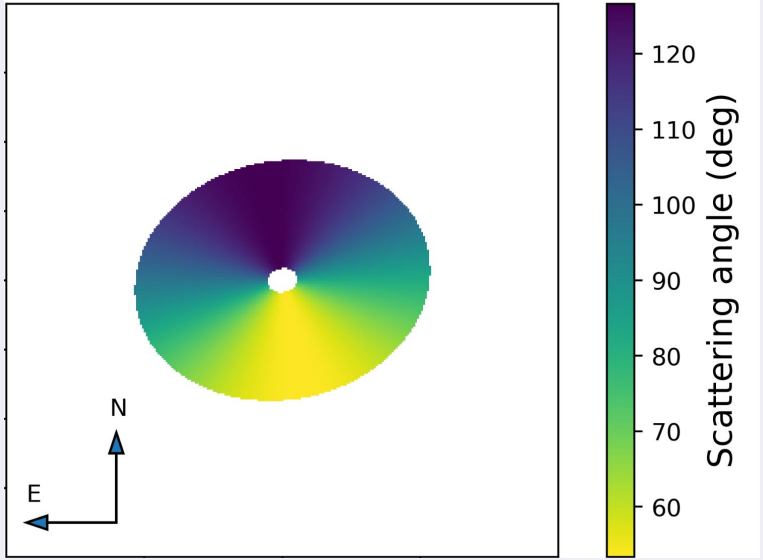
Radiative transfer modeling to determine geometric parameters



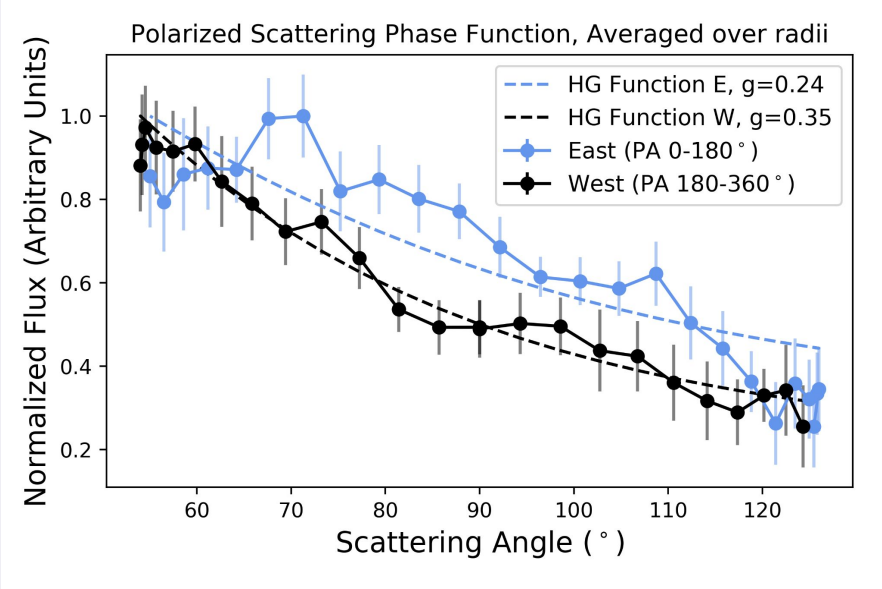
Lewis et al. in prep, via MCFOST (Pinte et al. 2006)

Visualizing the scattering geometry of the system



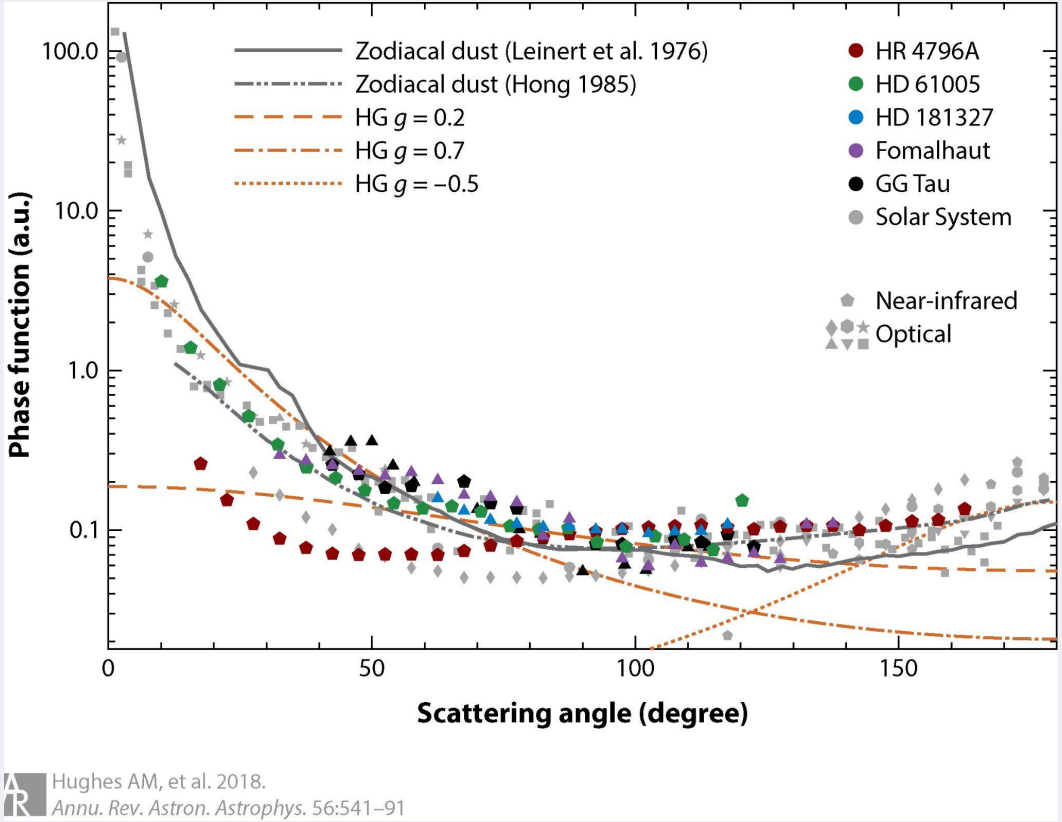


Phase functions help characterize scattering properties of the dust



Lewis et al. in prep

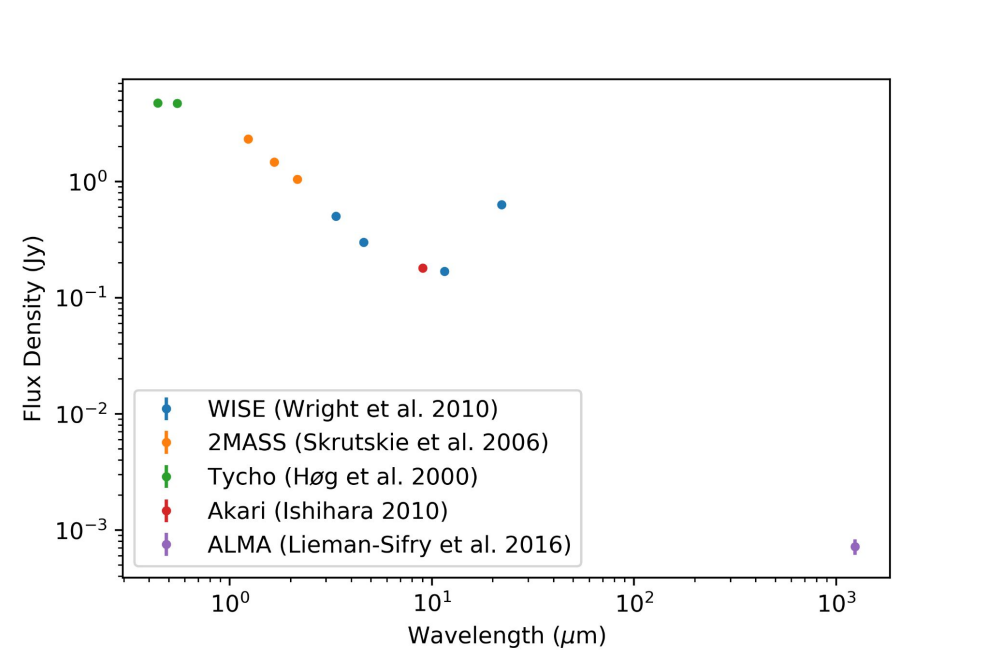
Phase functions across uniform samples



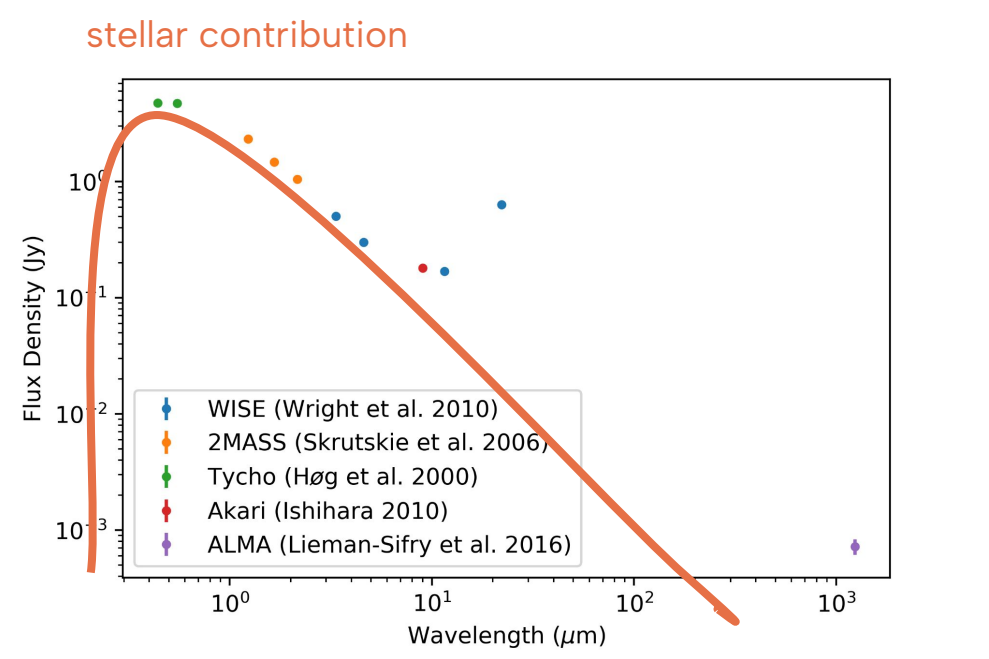
Hughes AM, et al. 2018.
Annu. Rev. Astron. Astrophys. 56:541–91

Hughes 2018

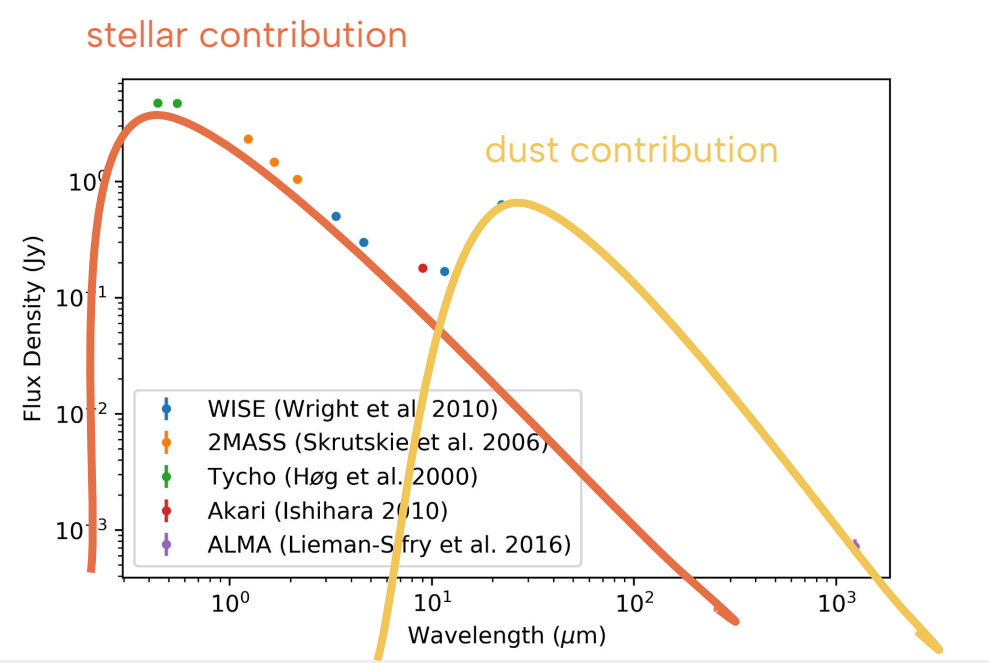
Modeling the SED



Modeling the SED

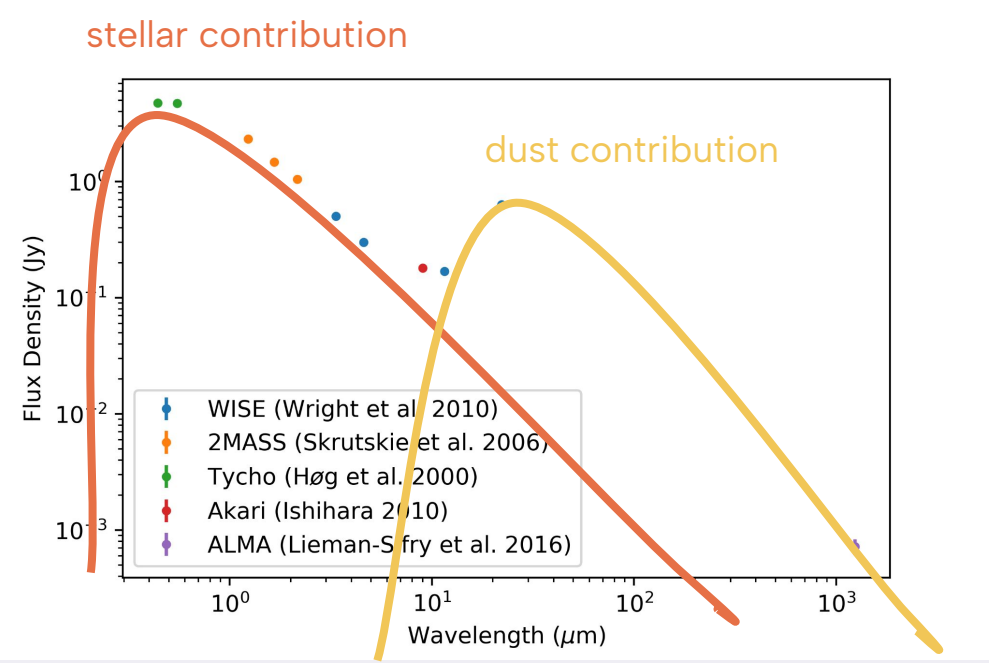


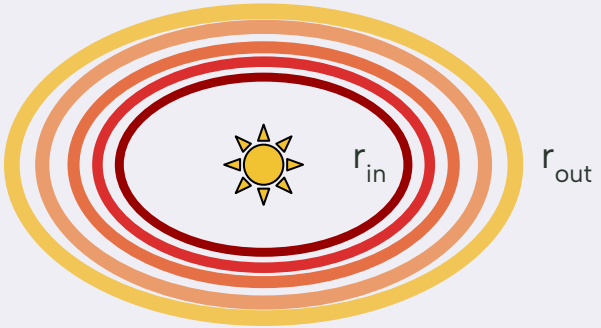
Modeling the SED



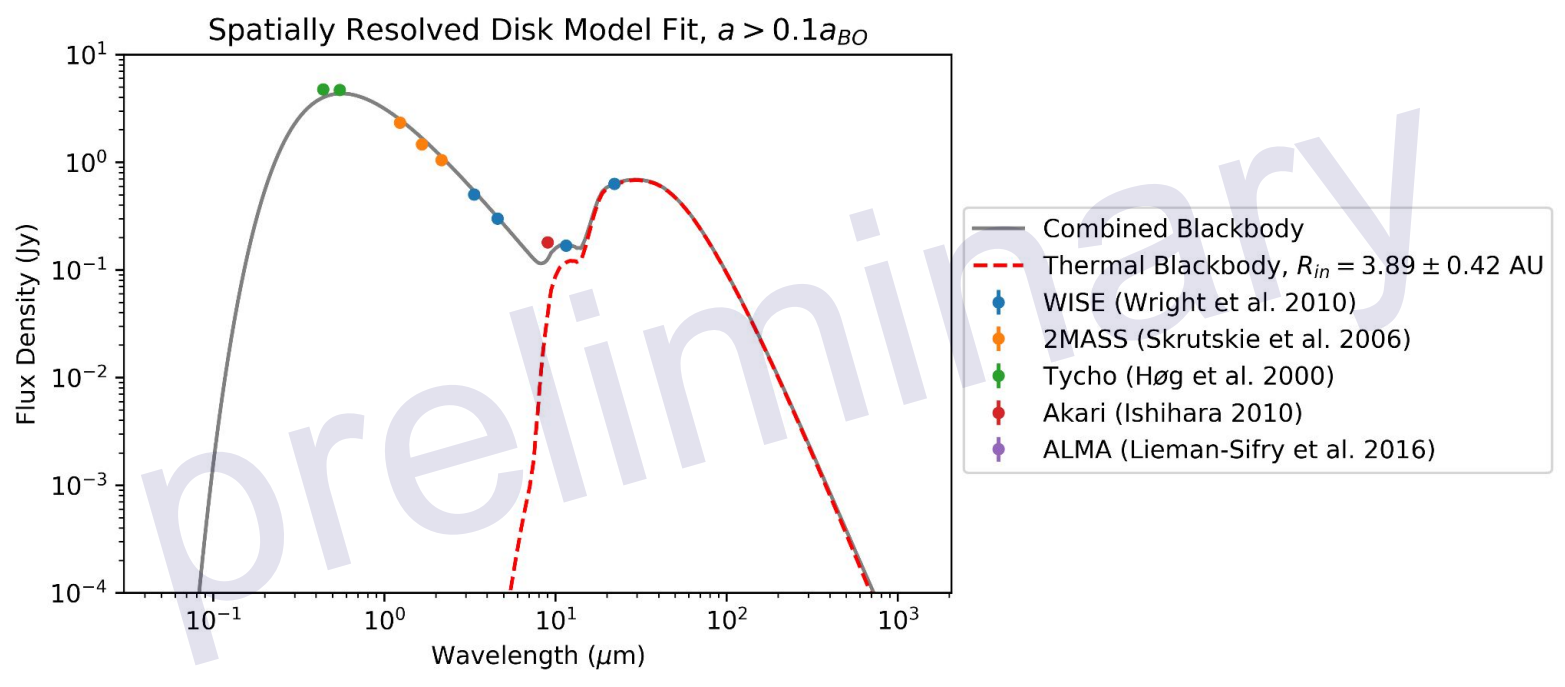
Lewis et al. in prep

Modeling the SED





$$j_{nu}(r) = Q(a)\, B_{nu}(T_{dust}(r))$$

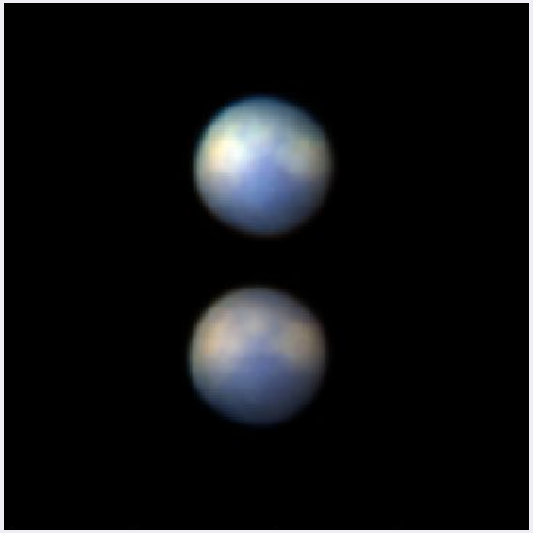

Spatially Resolved Disk Model Fit, $a > 0.1a_{BO}$
Flux Density (Jy)
Wavelength (μm)
Combined Blackbody
Thermal Blackbody, $R_{in} = 3.89 \pm 0.42$ AU
WISE (Wright et al. 2010)
2MASS (Skrutskie et al. 2006)
Tycho (Høg et al. 2000)
Akari (Ishihara 2010)
ALMA (Lieman-Sifry et al. 2016)
preliminary

Takeaway: HD 156623's debris disk has an inner radius of ~4 AU and evidence of sub-blowout size grains, hinting at the role of gas drag in retaining small grains

Bonus: Europa!

Work in progress :)

Polarized light is generated by scattering processes in many different contexts!

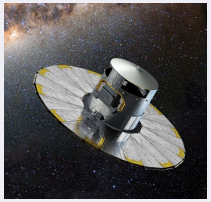


Lewis et al. in prep / Subaru SCExAO/CHARIS

Other things I'm working on

Astrobites educational resources

Ready-to-use lesson plans, and education research to back them up (takeaway = good for student confidence with research papers!



Hipparcos-Gaia accelerations follow-up

Informed searches for substellar companions with Keck NIRC2 and Subaru CHARIS

Science writing

Education research on how we can teach astro students writing + how writing-focused lessons impact students

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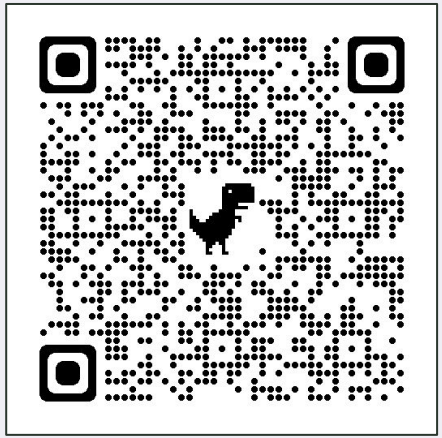

Thanks for listening!