A Direct Imager's Guide to Debris Disks

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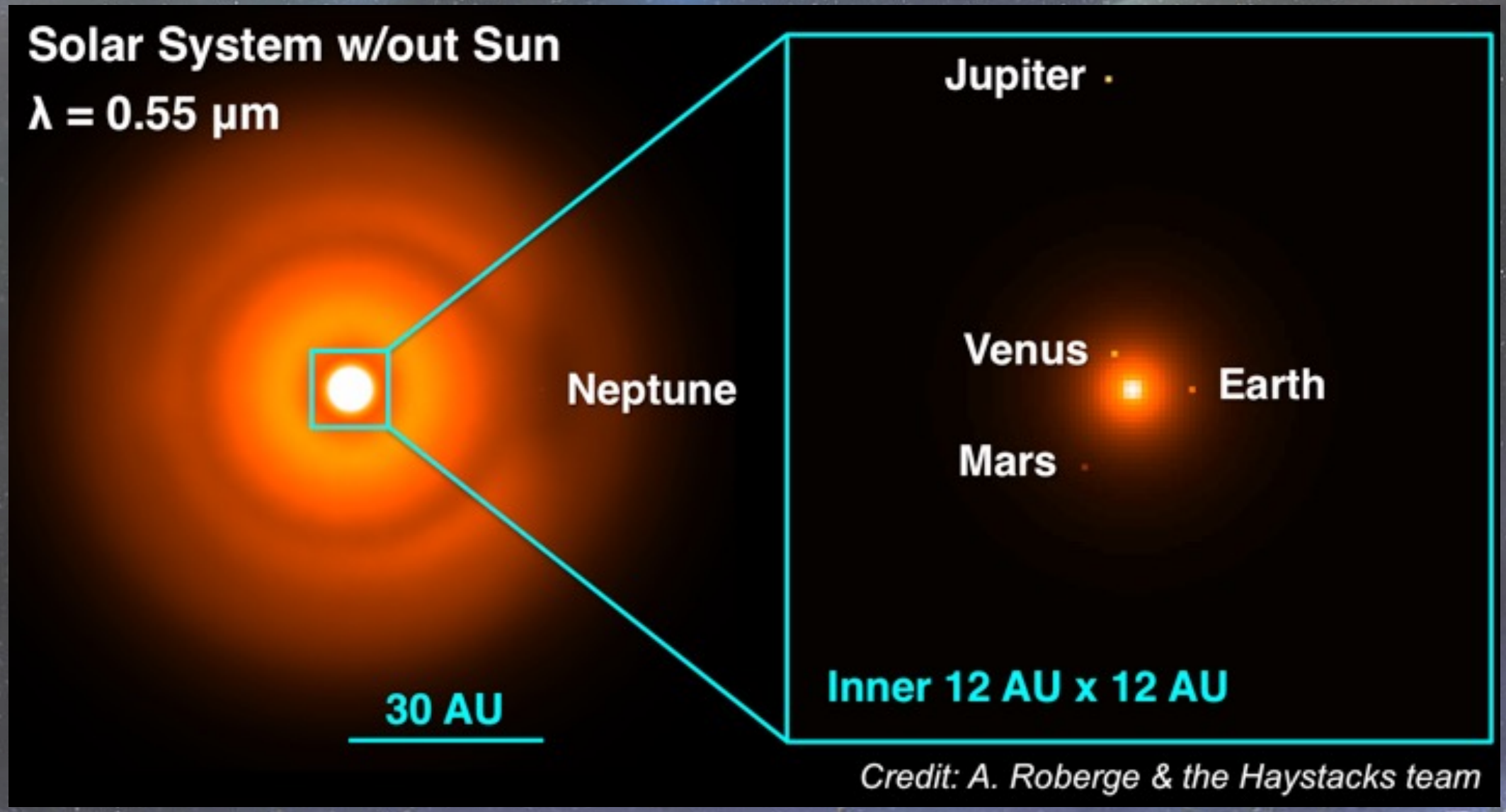
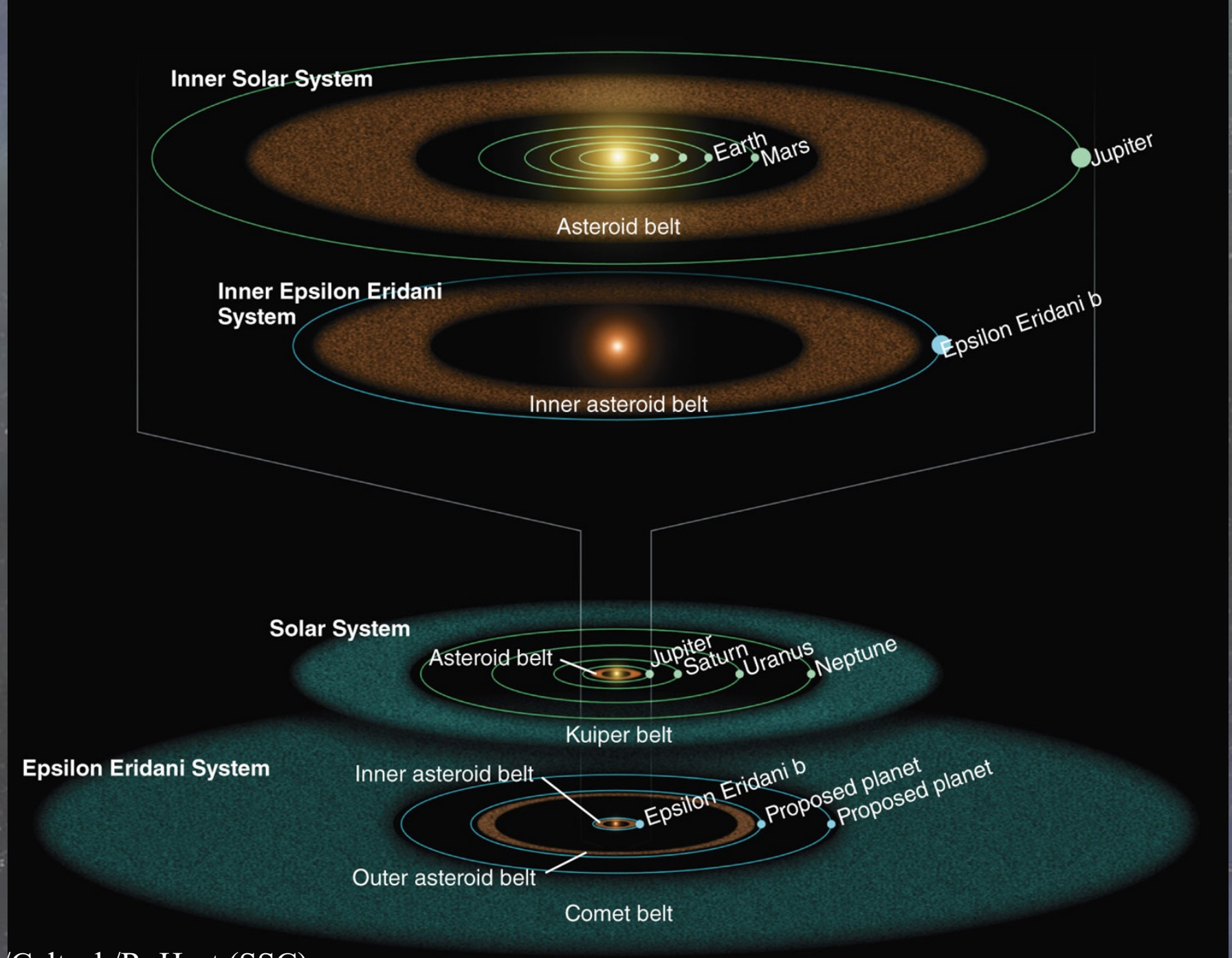
esa

Circumstellar dust samples the environment of stars

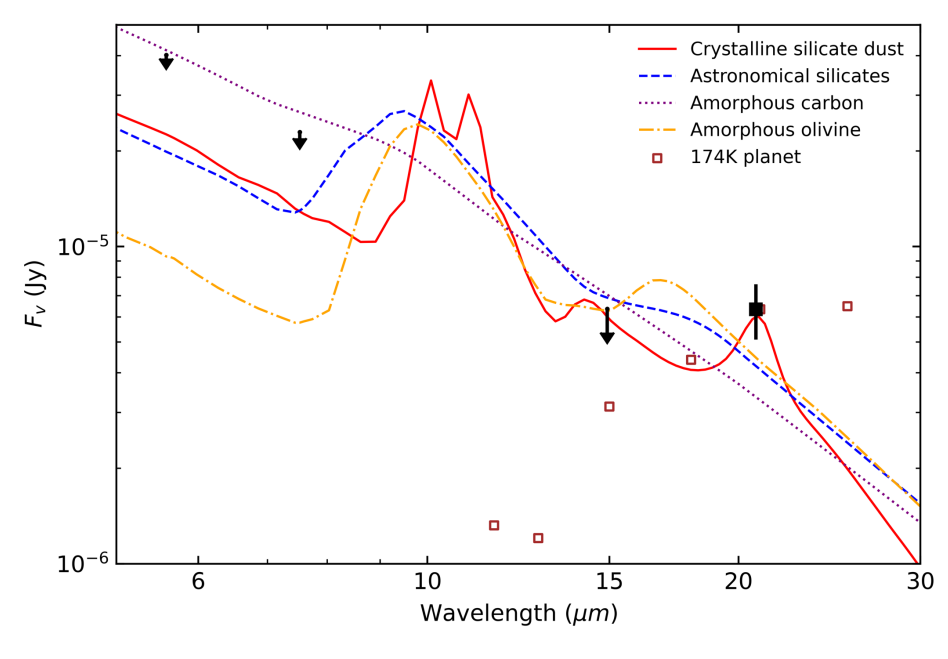
Debris Disks—a diversity of types



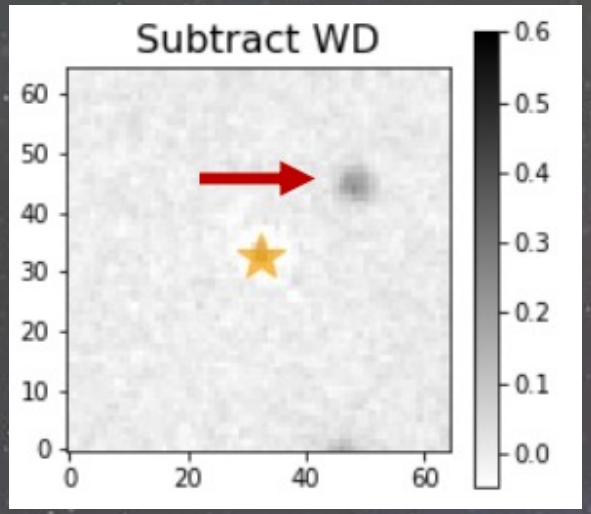


Credit: NASA/JPL/Caltech/R. Hurt (SSC)

White Dwarf Debris Disks

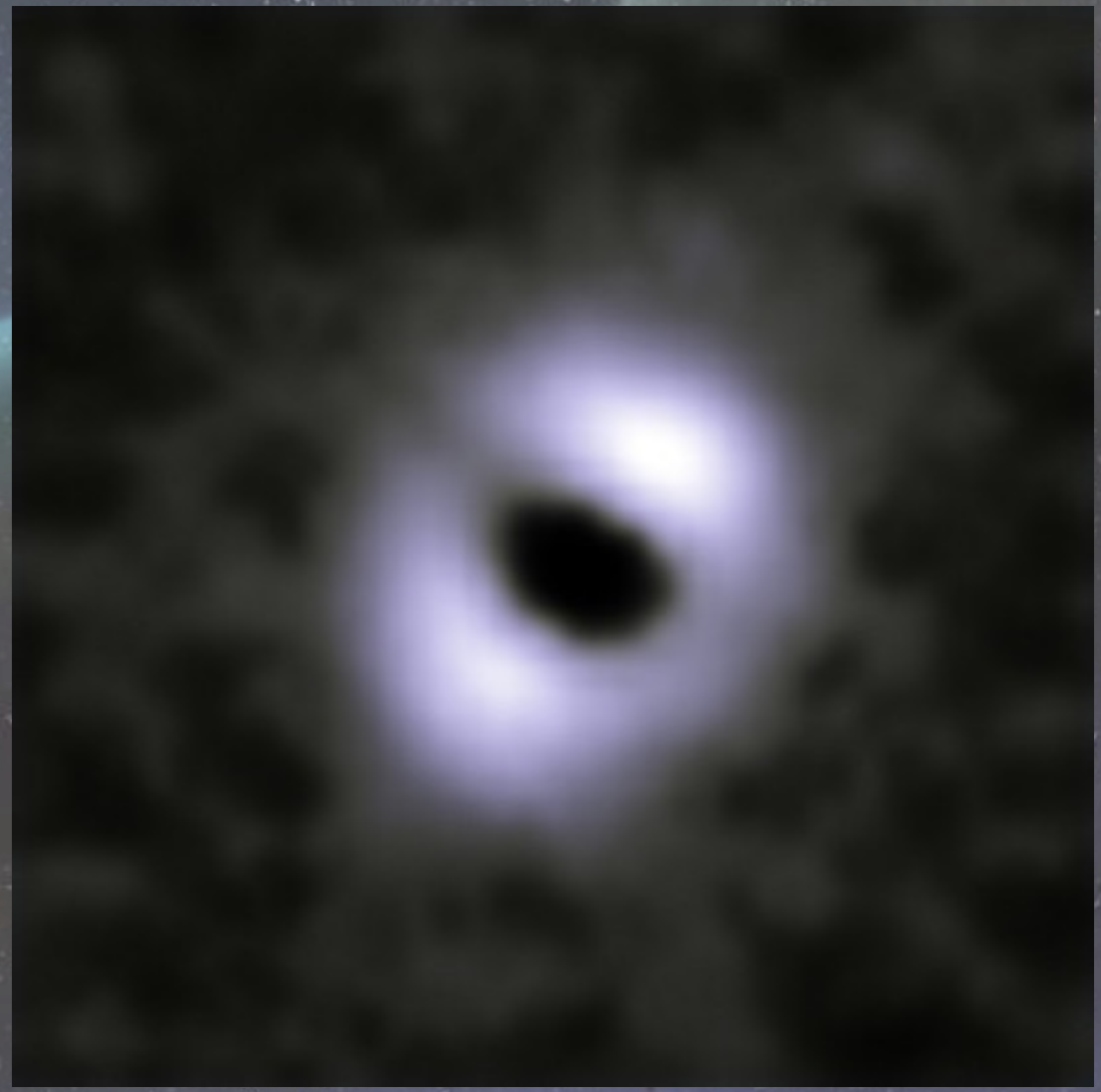


White Dwarf Planets with JWST?



Messier et al., (in prep.); Mullally et al., (2024)

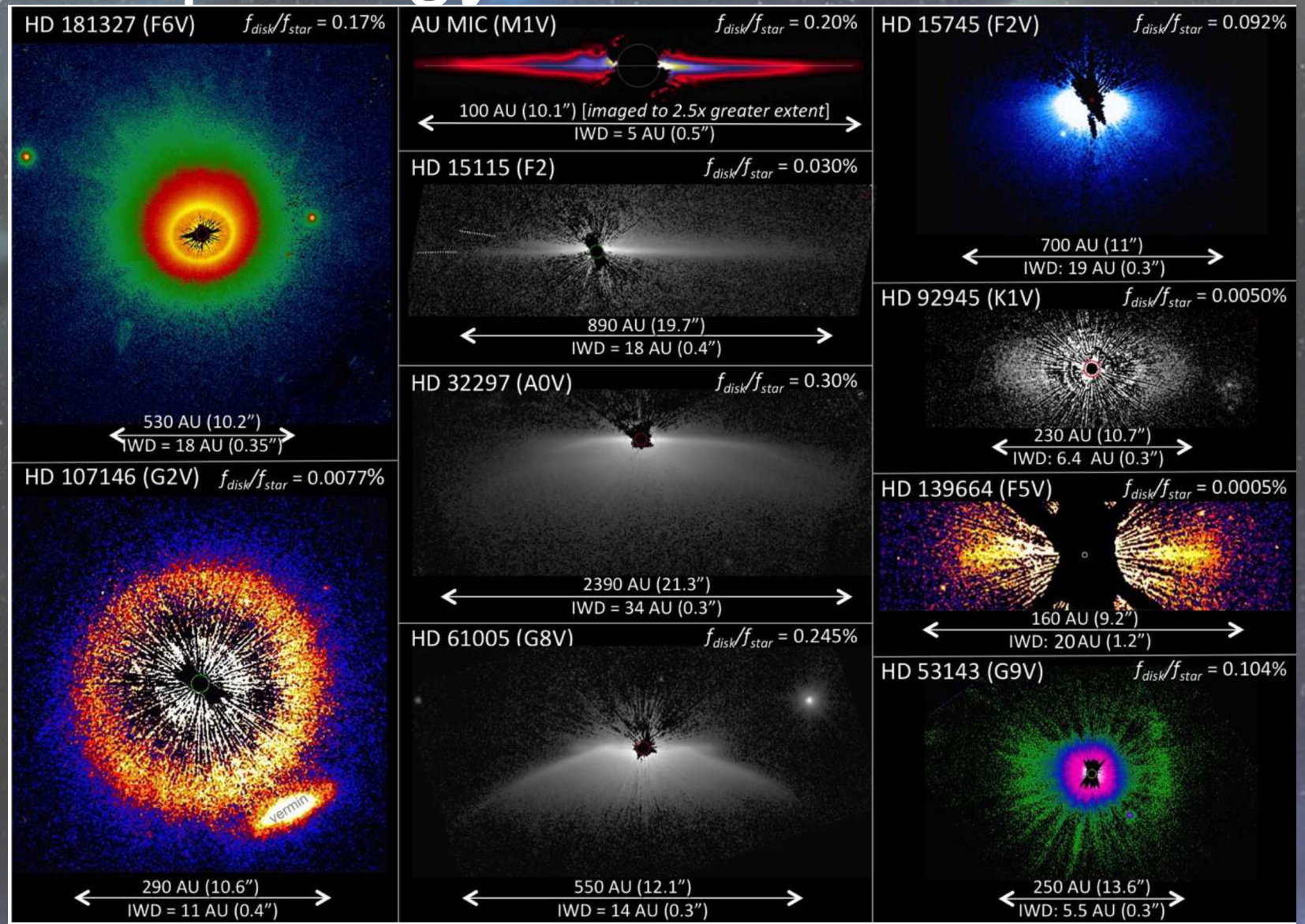
Giant Star Debris Disks



Credit: A.Bonsor/ESA

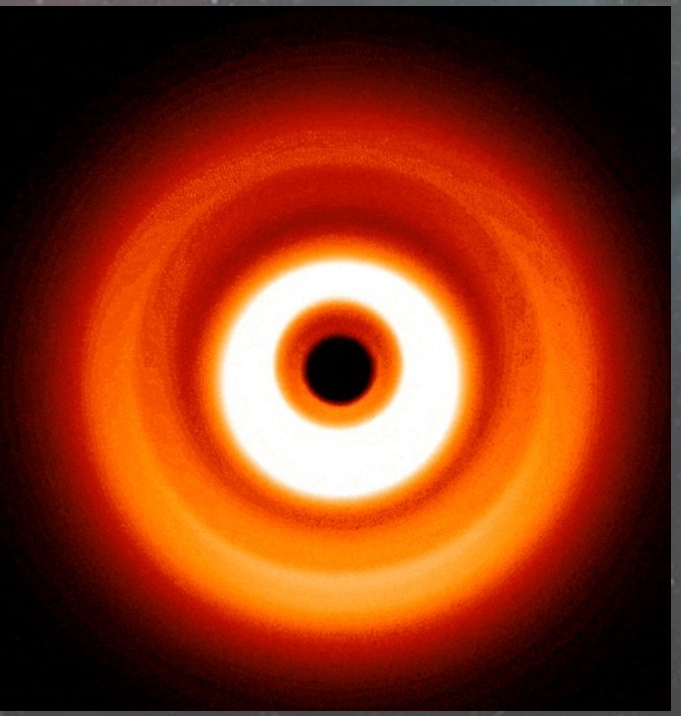
Posters: 23 Hosseininezhad; 51 Voyer

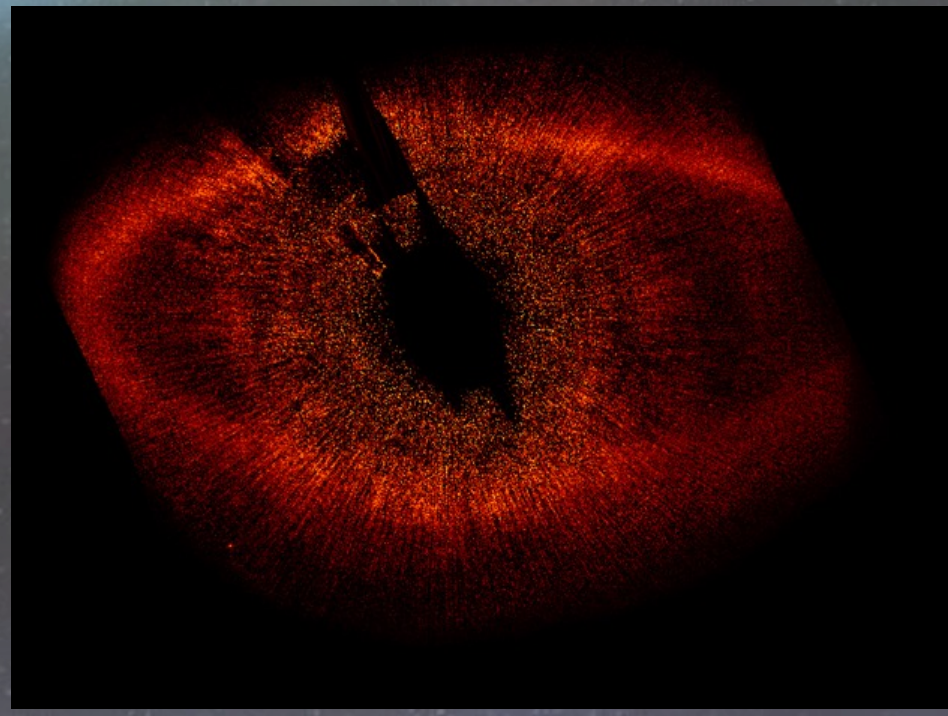
Diverse morphology



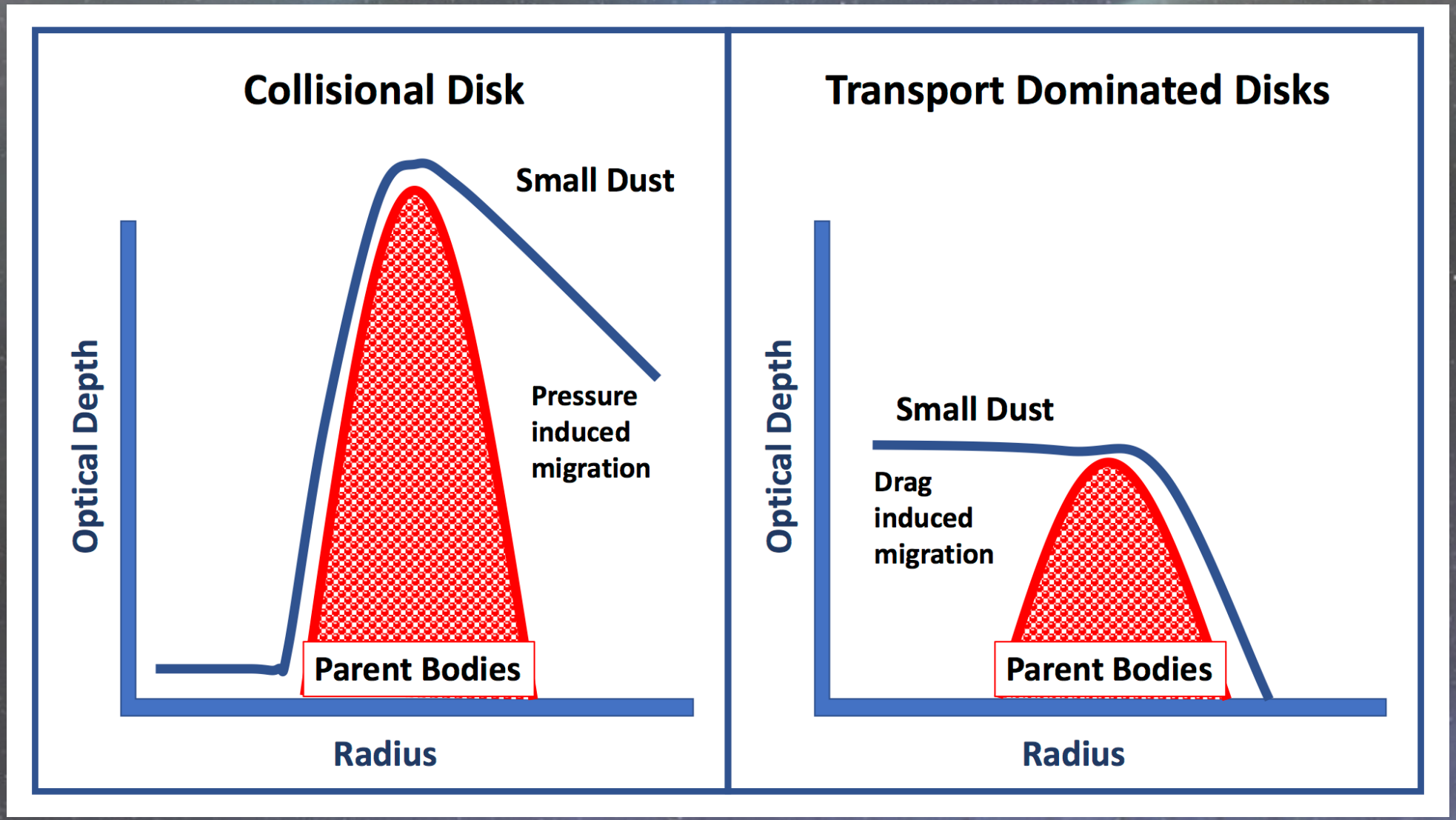
Schneider et al., 2014

Simple(?) Explanation

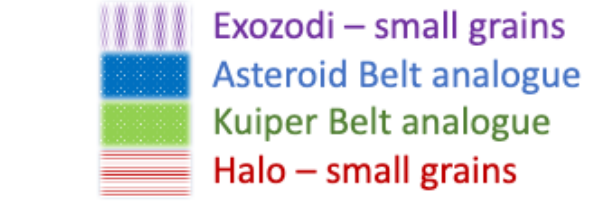


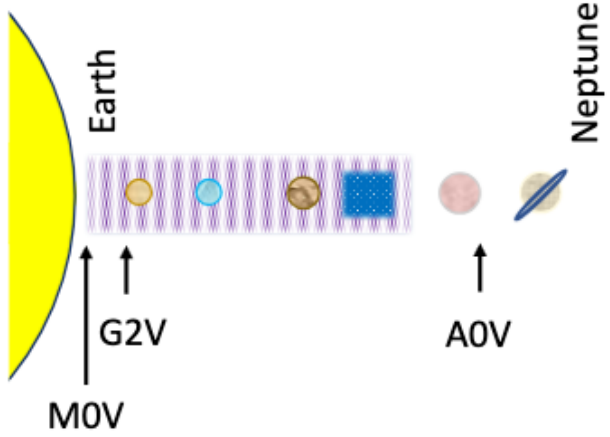


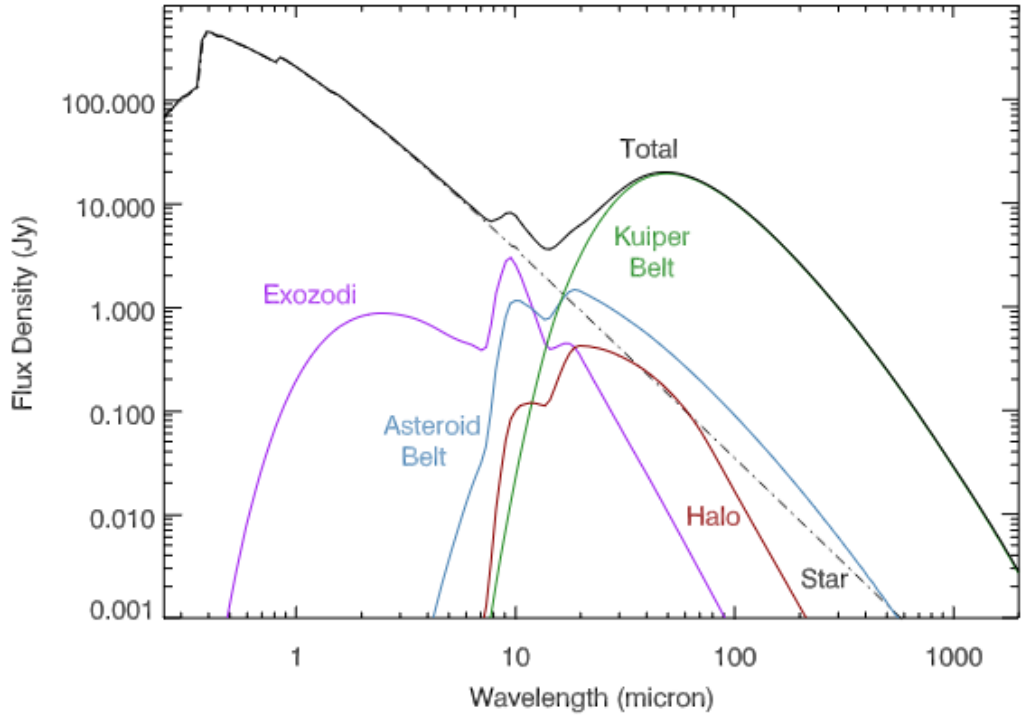
Simple(?) Explanation



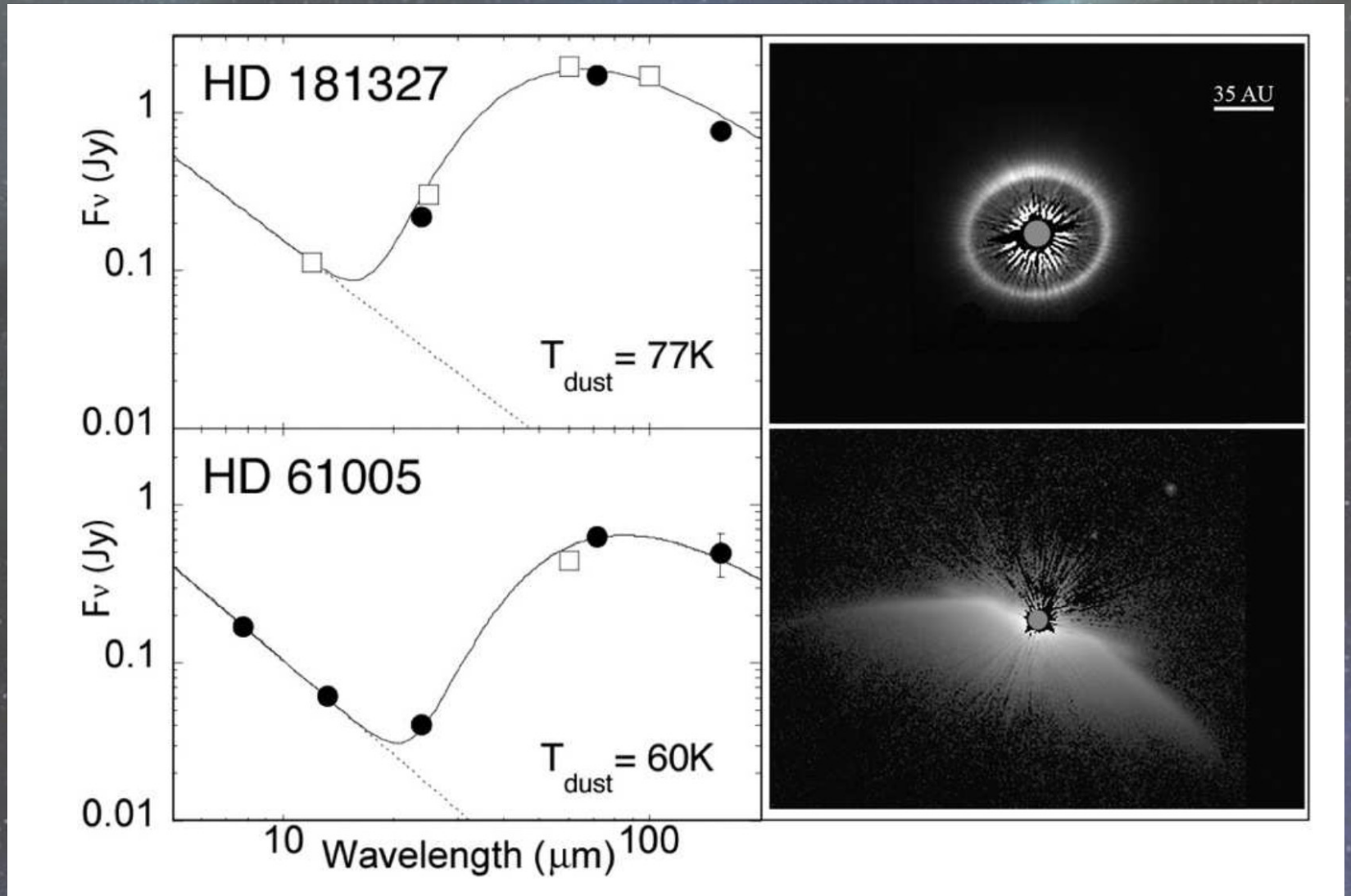
Observing Disks

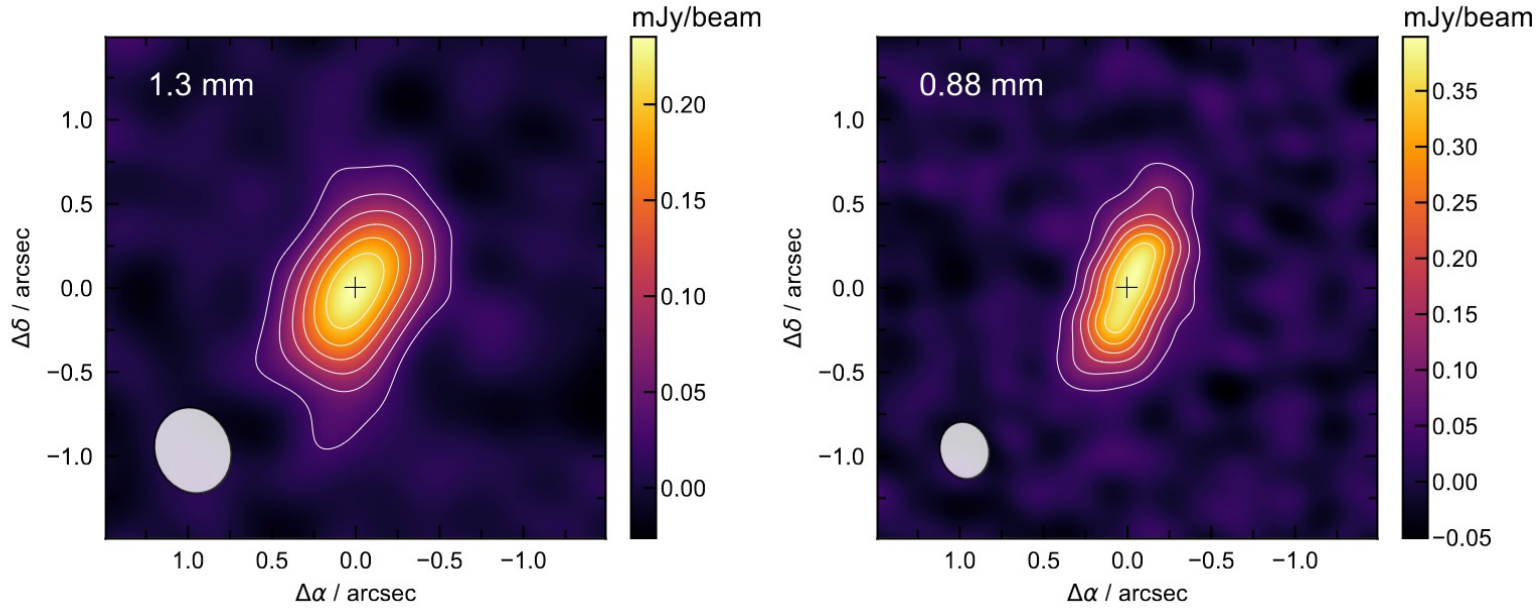


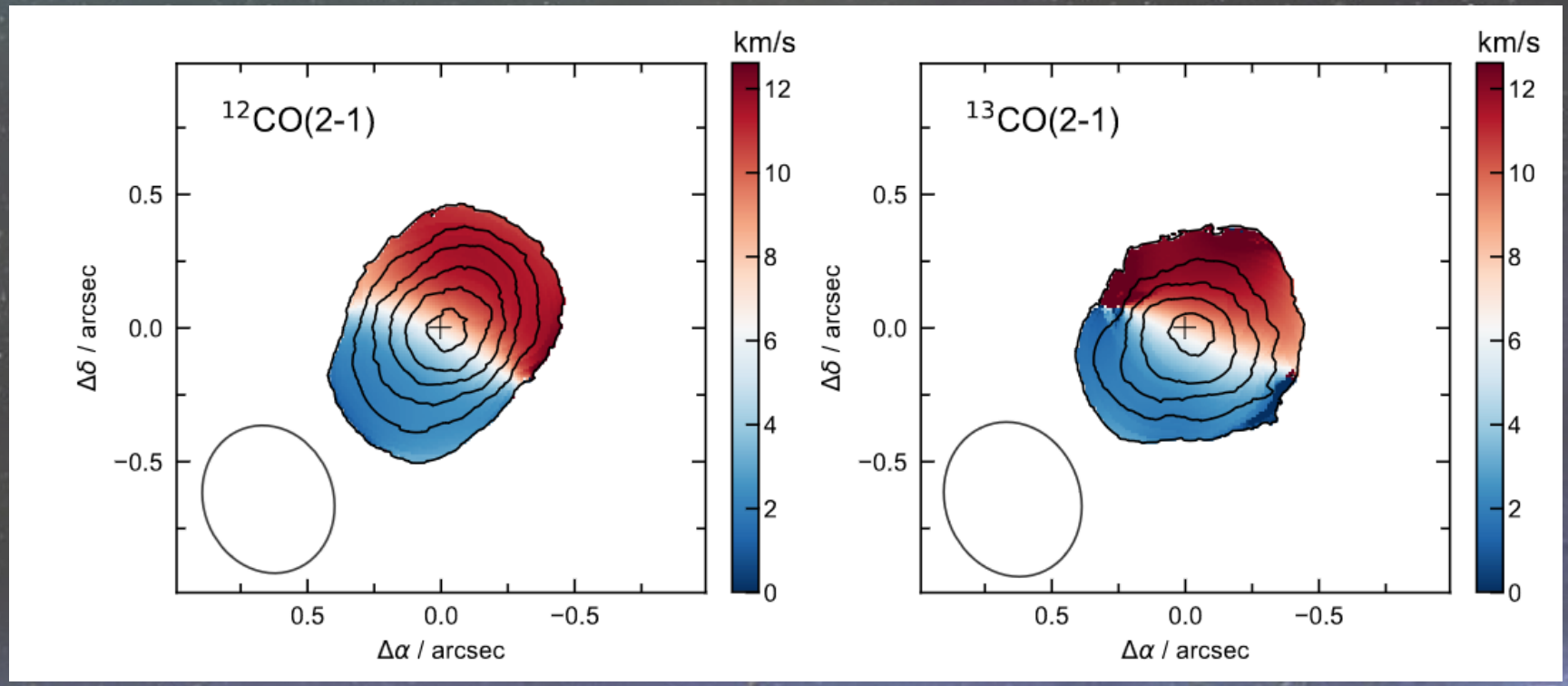




SEDs are limited in interpreting morphology



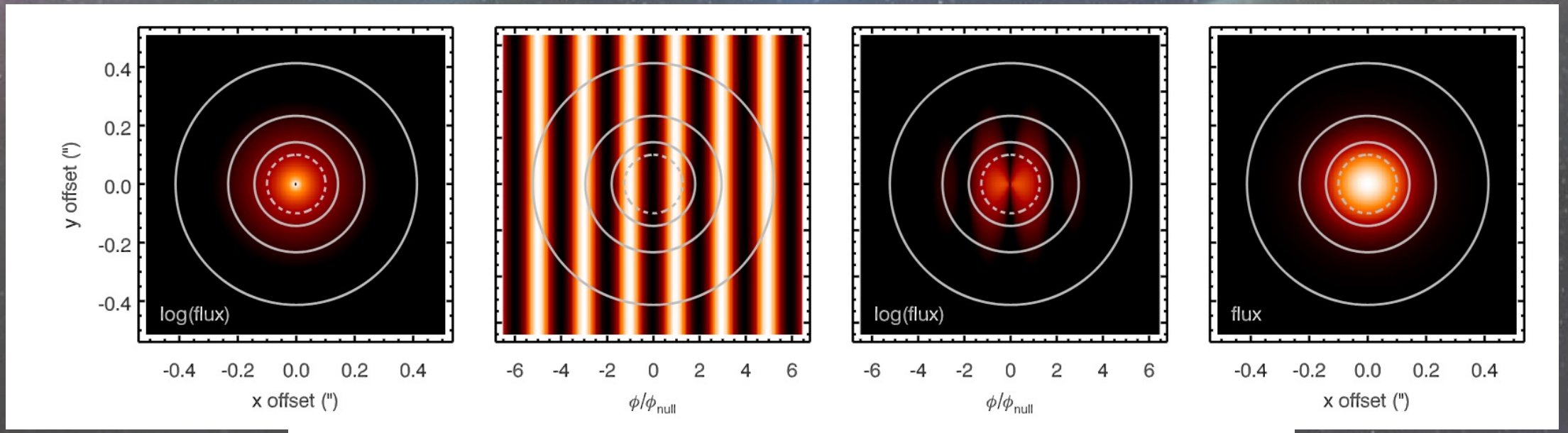


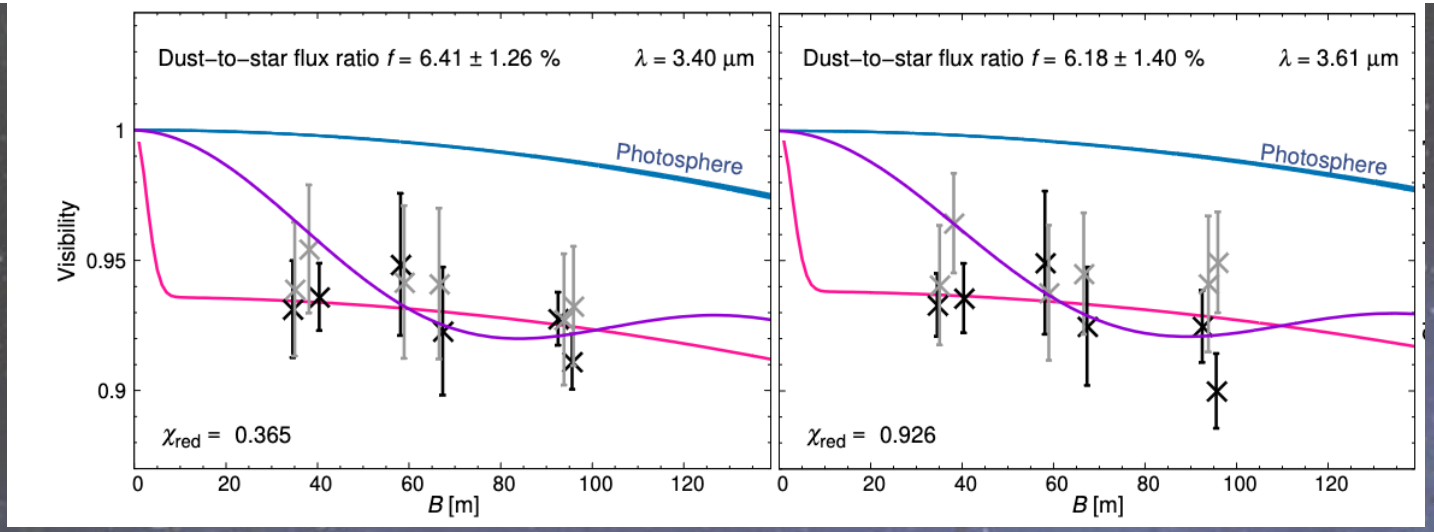


Hales et al., (2022)

Observing disks

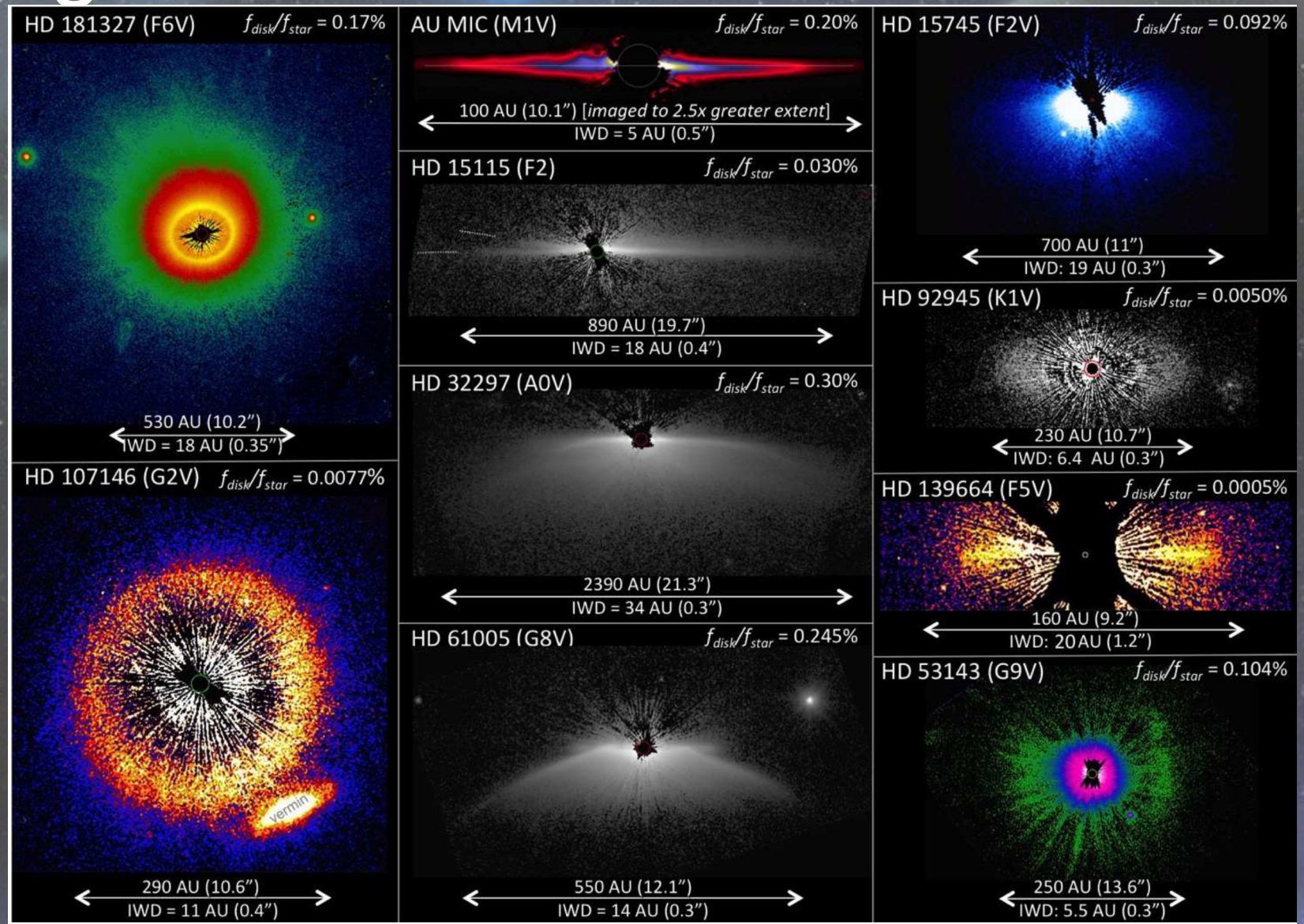
Ertel et al., (2018b)





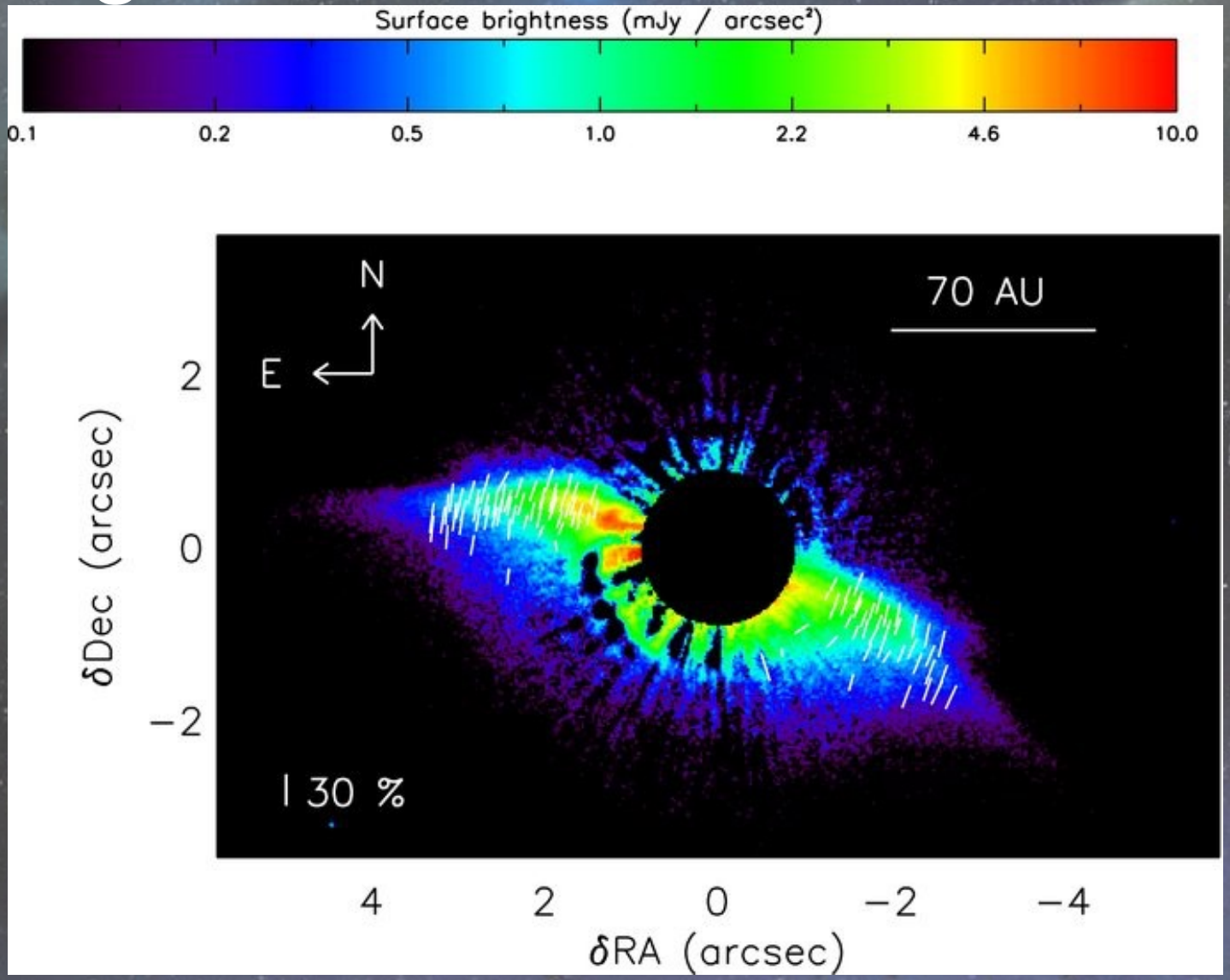
Kirchschlager et al., (2020)

Observing disks



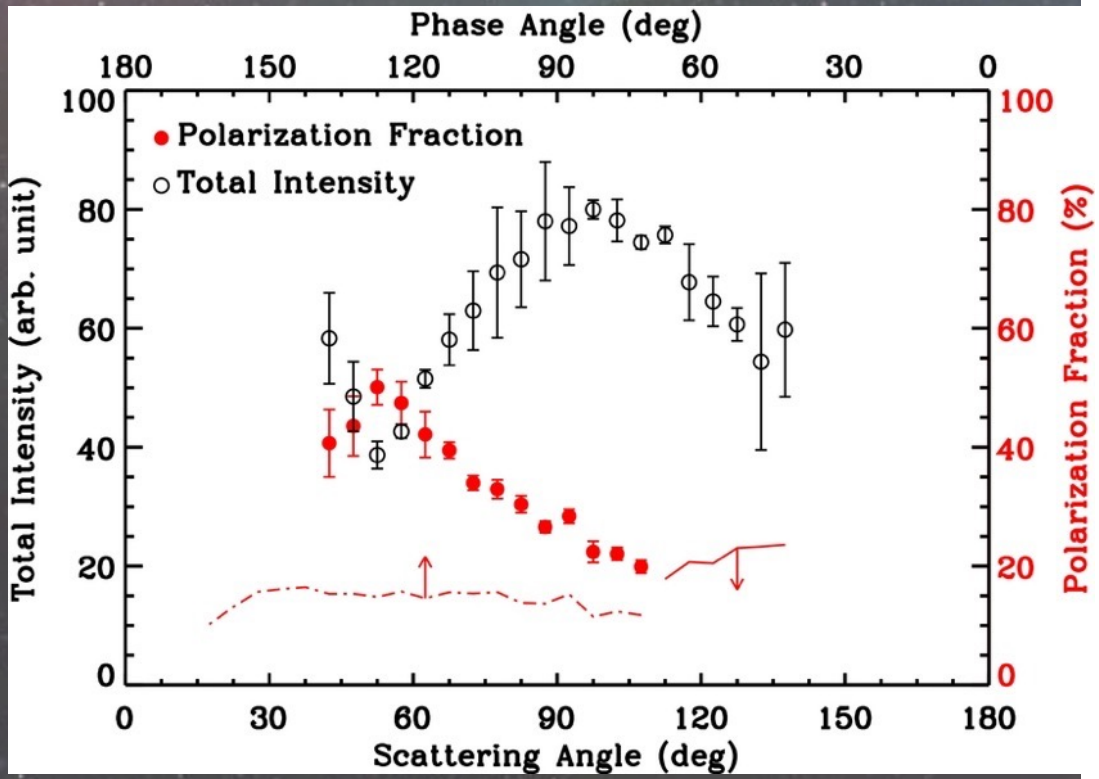
Schneider et al., 2014

Observing Disks

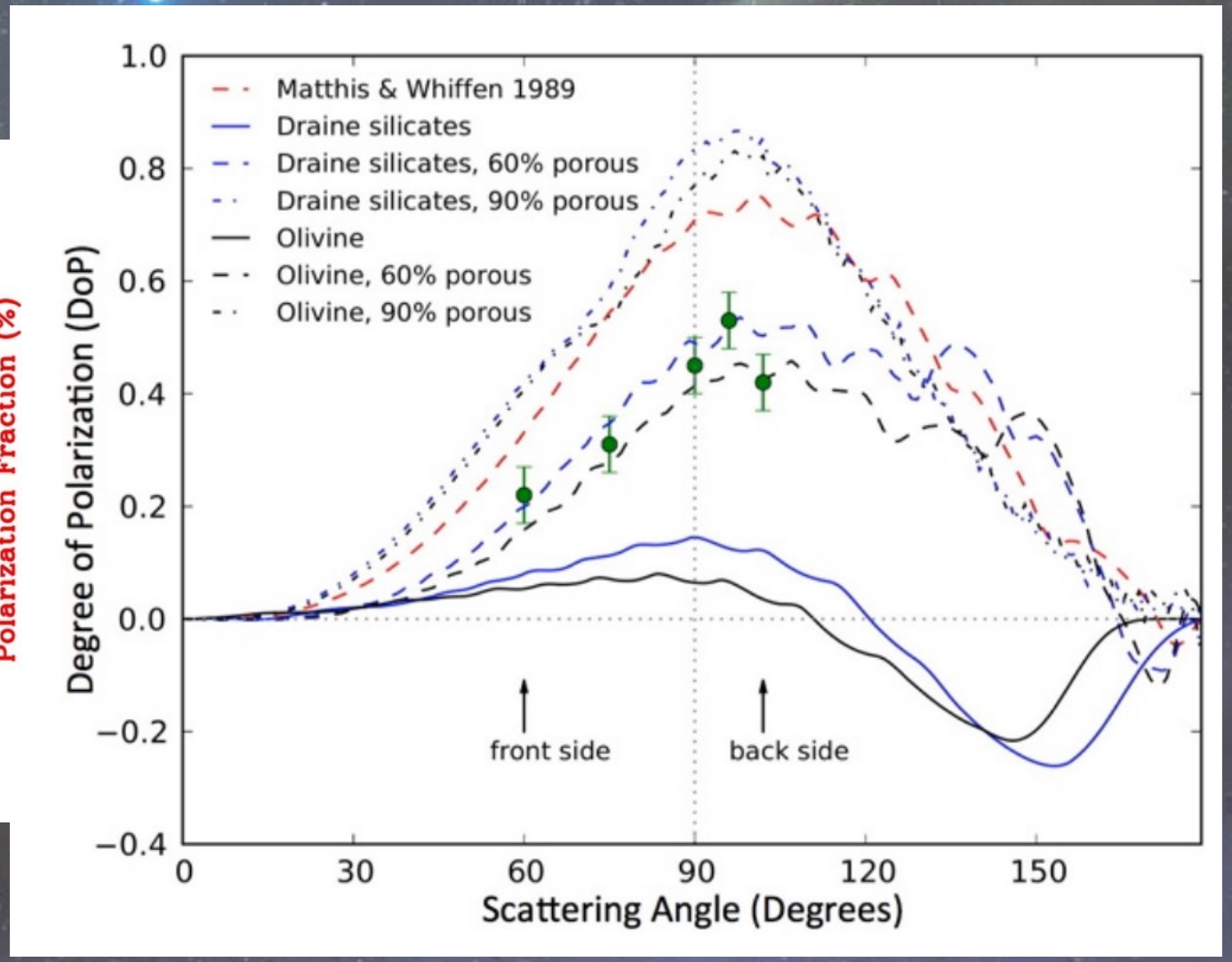


Maness et al., 2009

Observing Disks

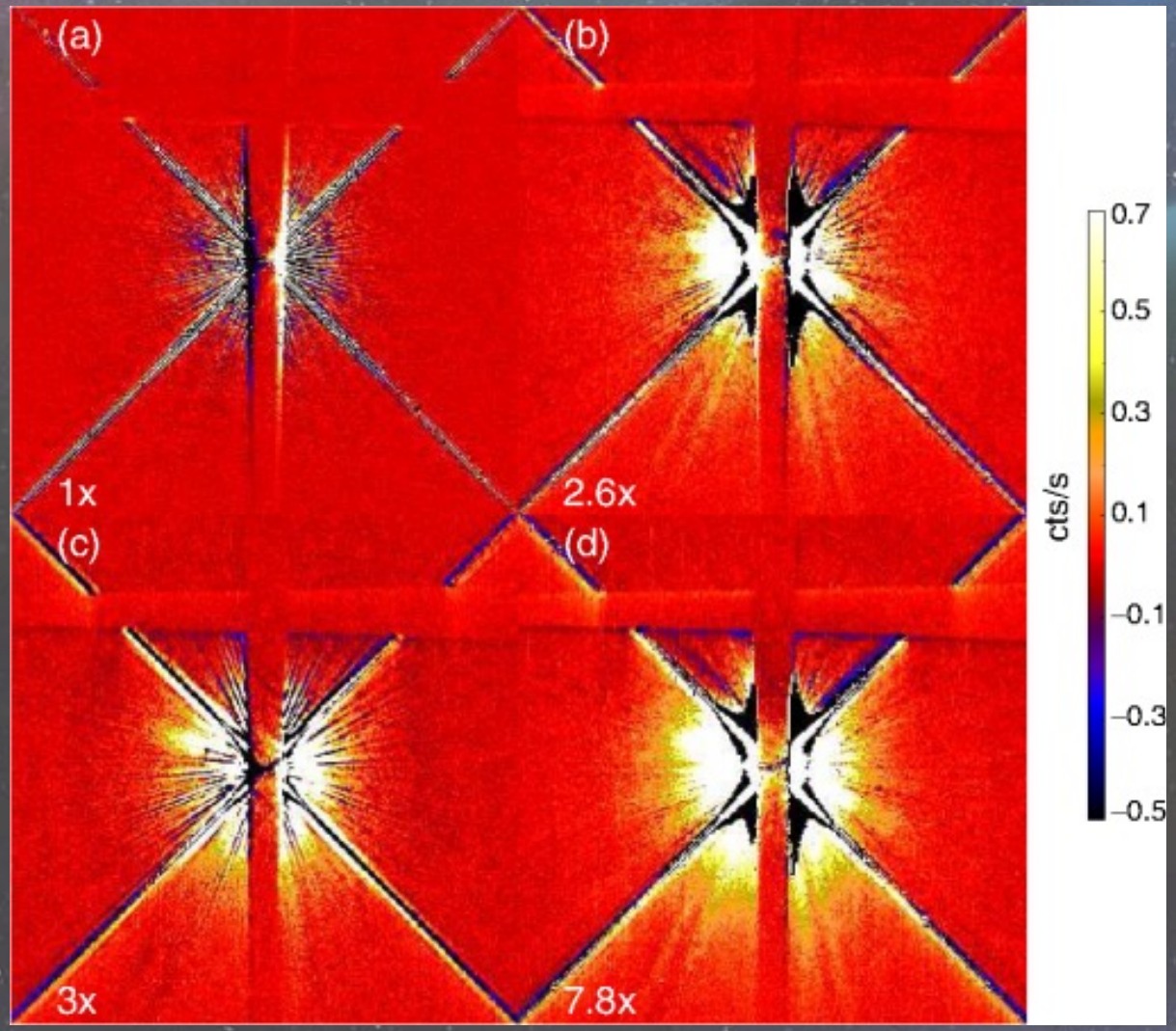


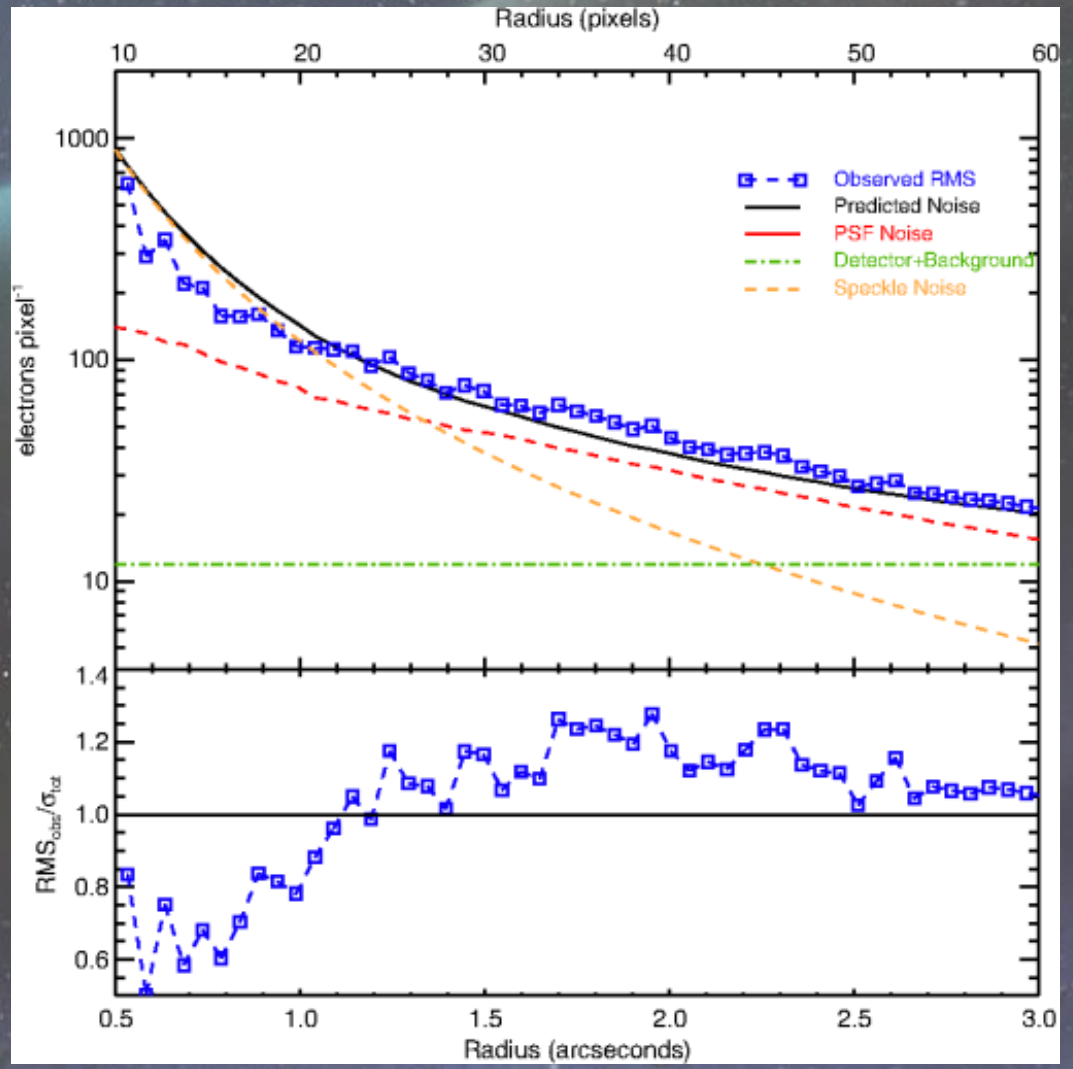
Perrin et al., 2015



Schneider et al., 2016

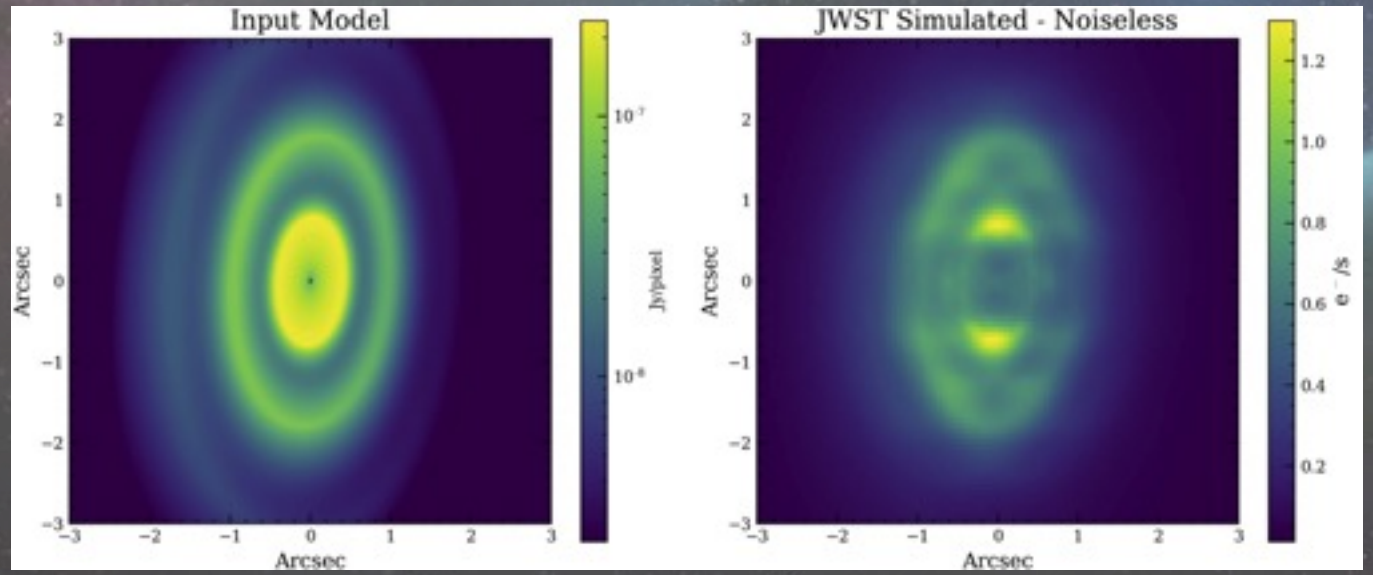
Technical details to directly imaging disks



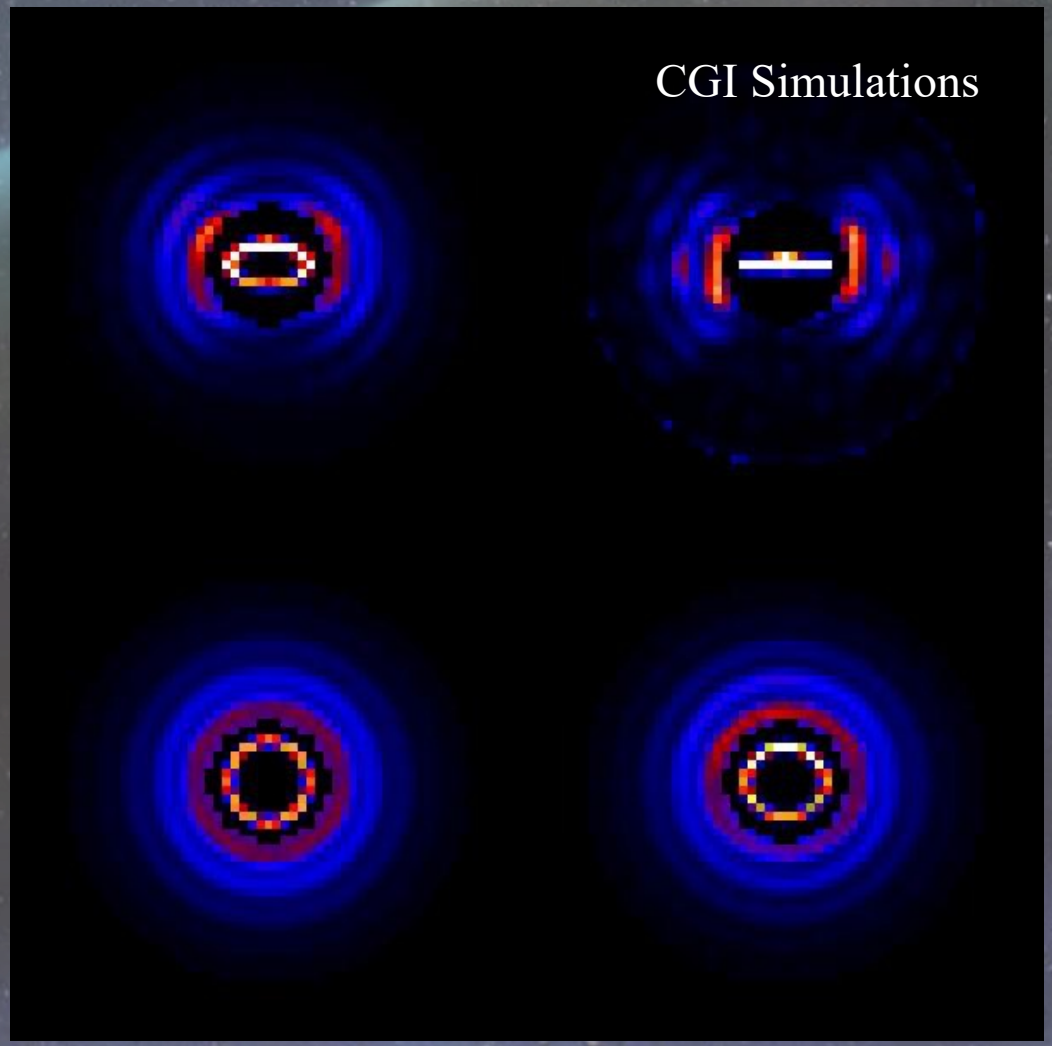


Debes et al., (2019)

Technical Details to Imaging Disks

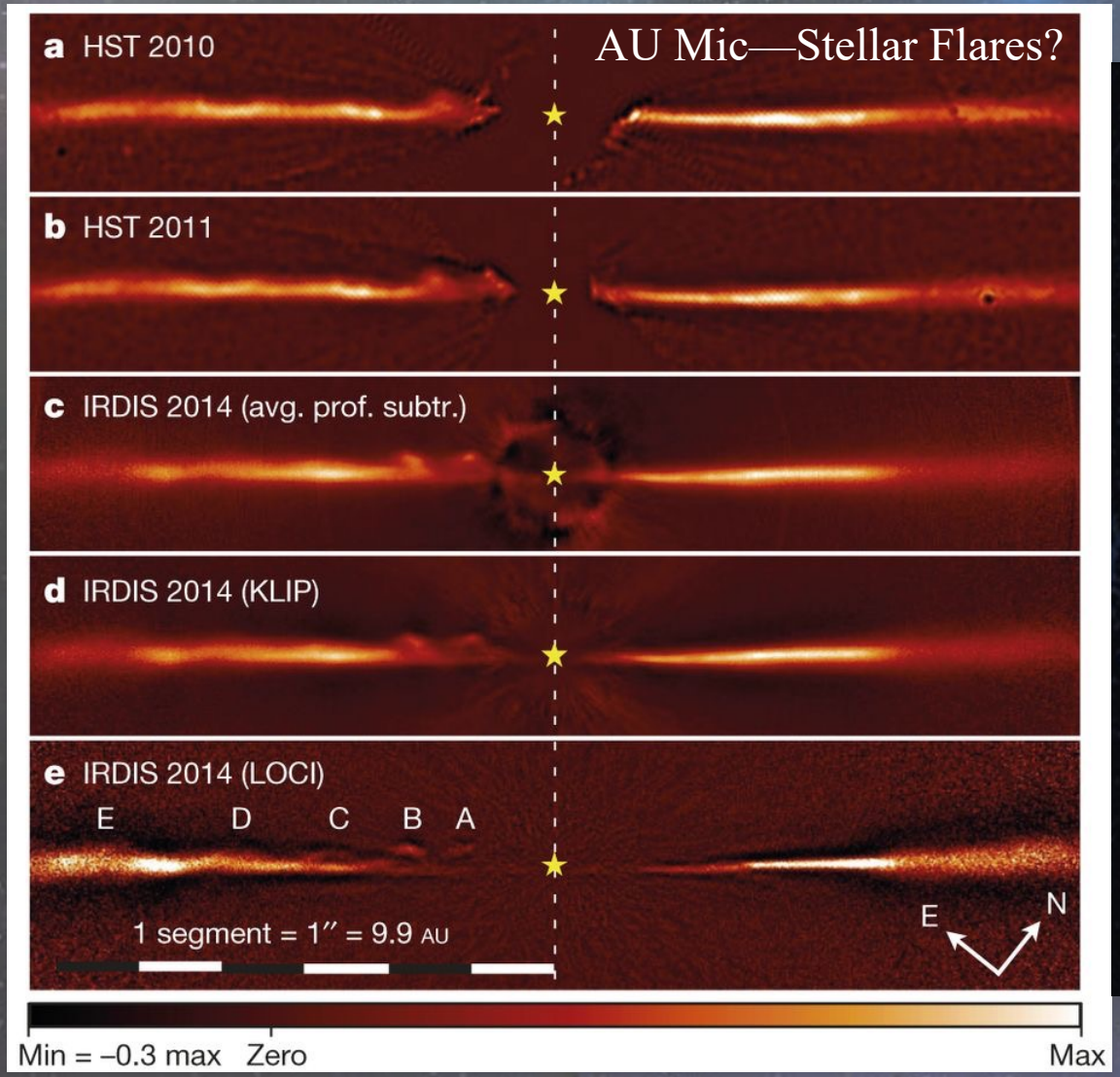


Hinkley et al., (2022)

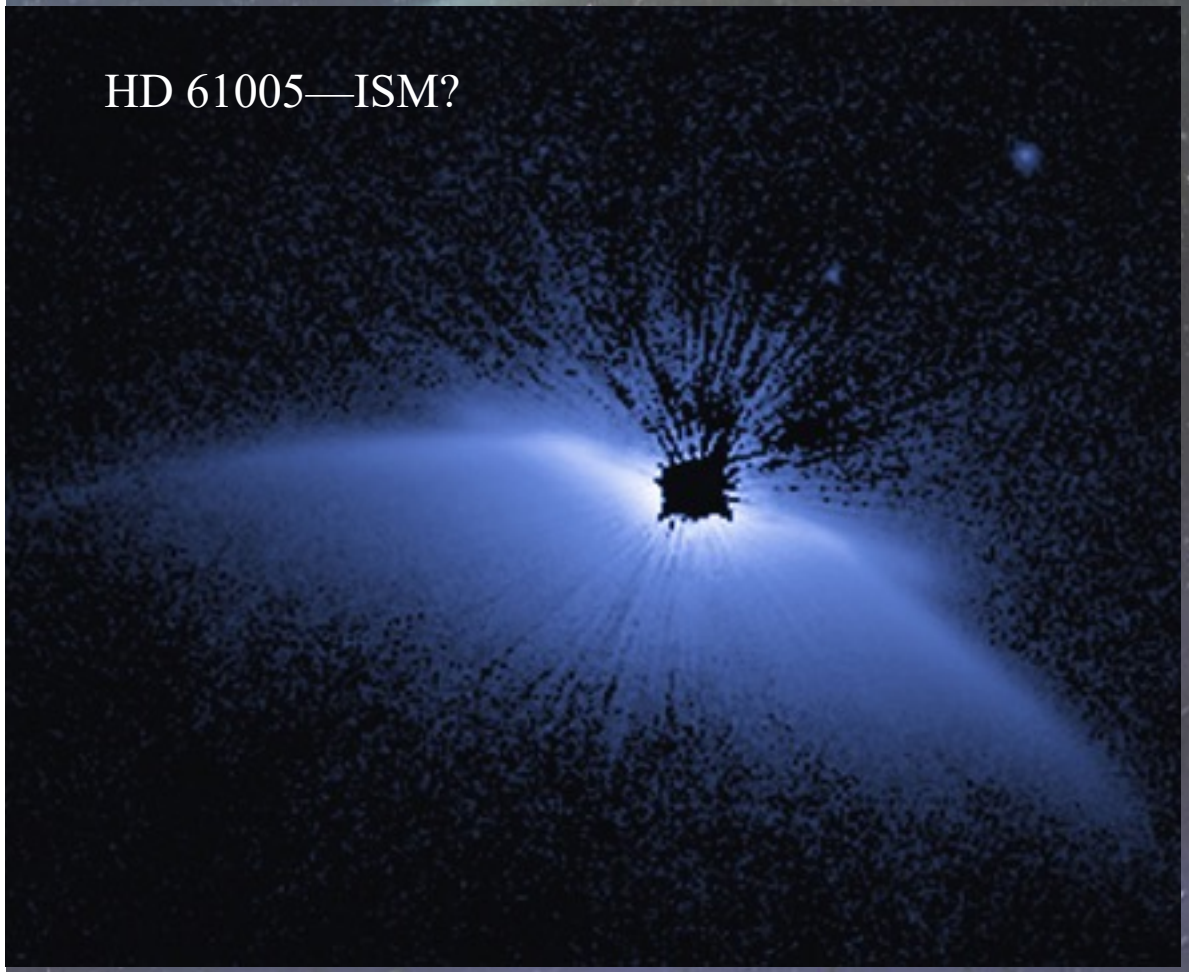


Posters: 31 Lin; 36 Mullin

Forces on debris disk dust

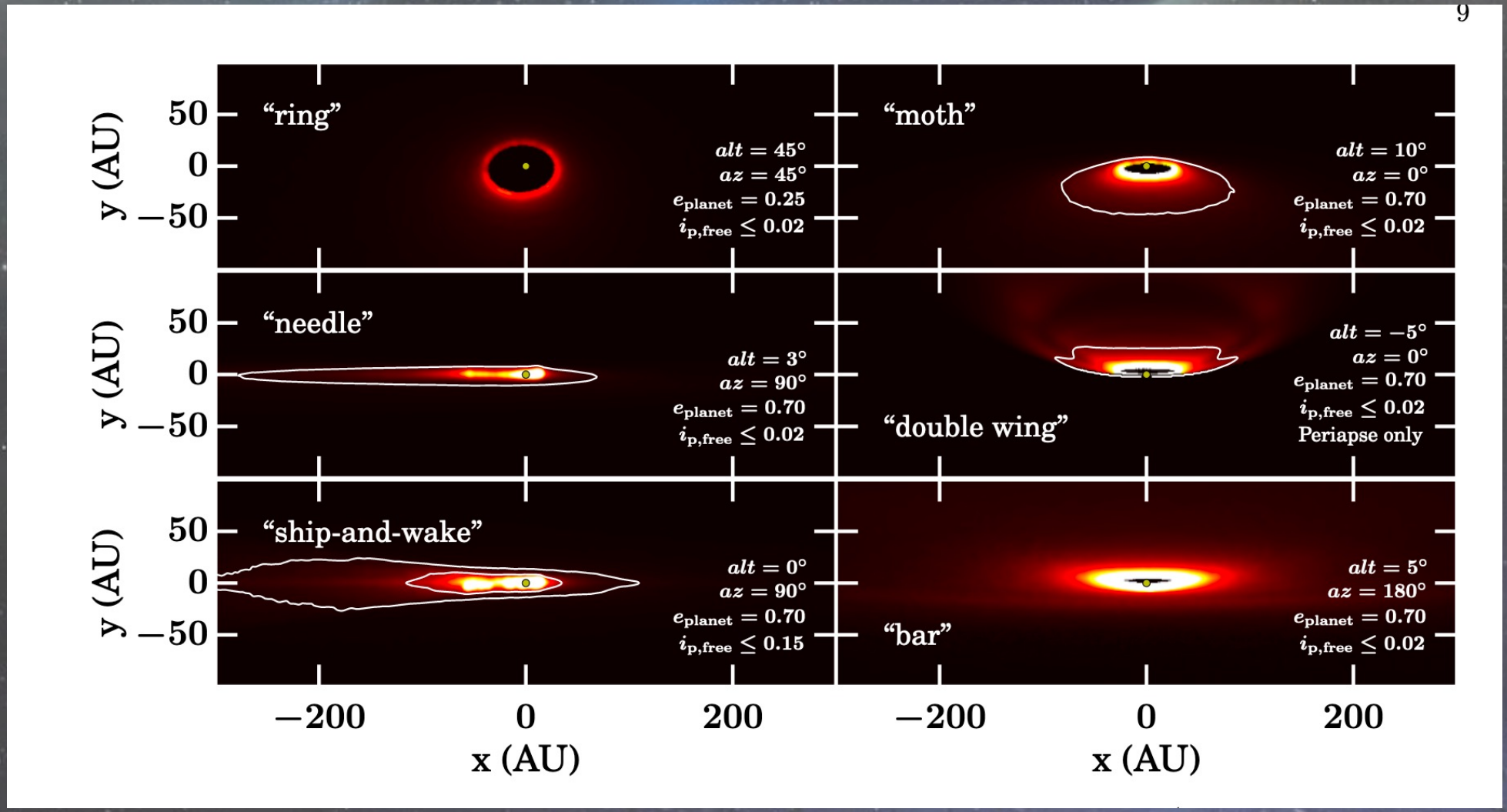


Boccaletti et al., 2015



Schneider et al., 2014

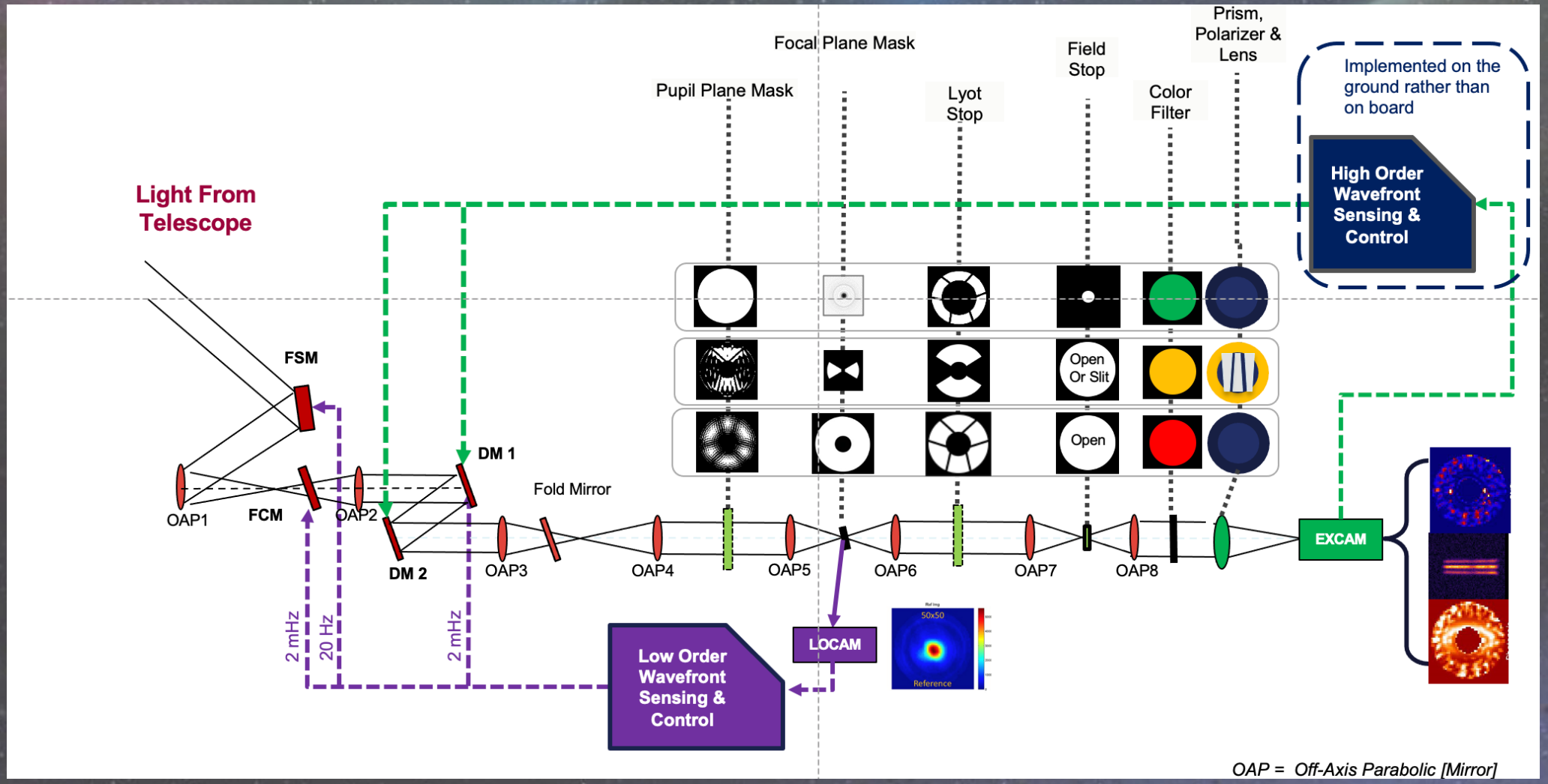
Forces on debris disk dust



Lee & Chiang (2016)

Posters: 2 Avsar; 6 Bovie; 42 Stuber; 82 Malin

New Frontiers—Exozodis and Hot Dust



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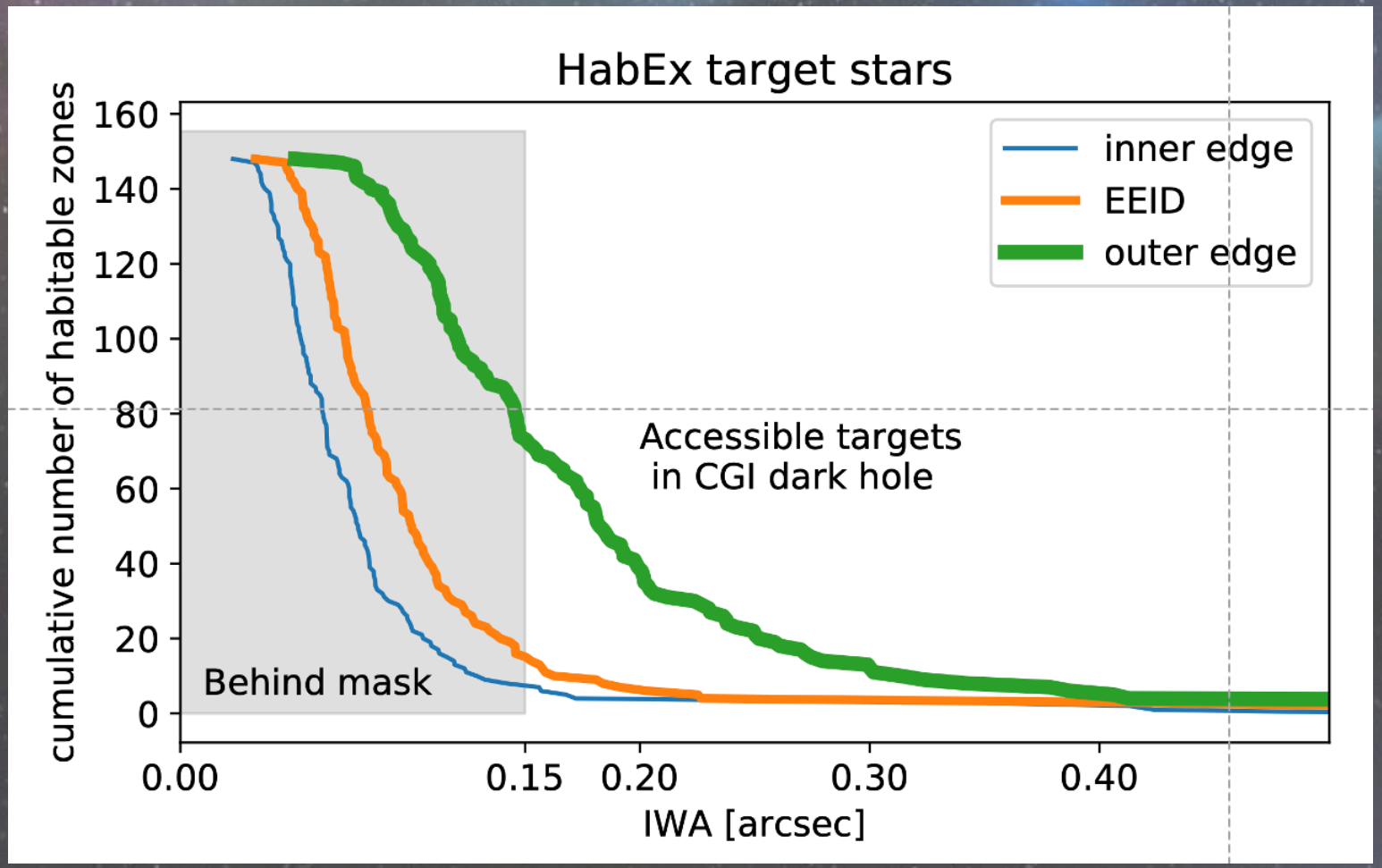
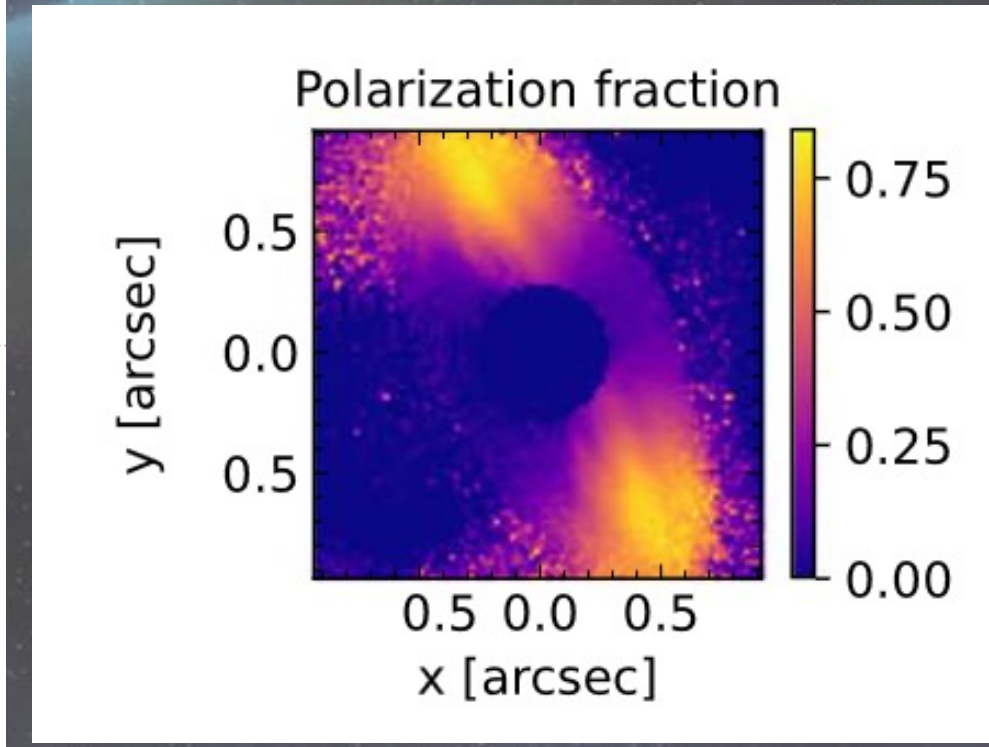
Posters:41 Sanghi

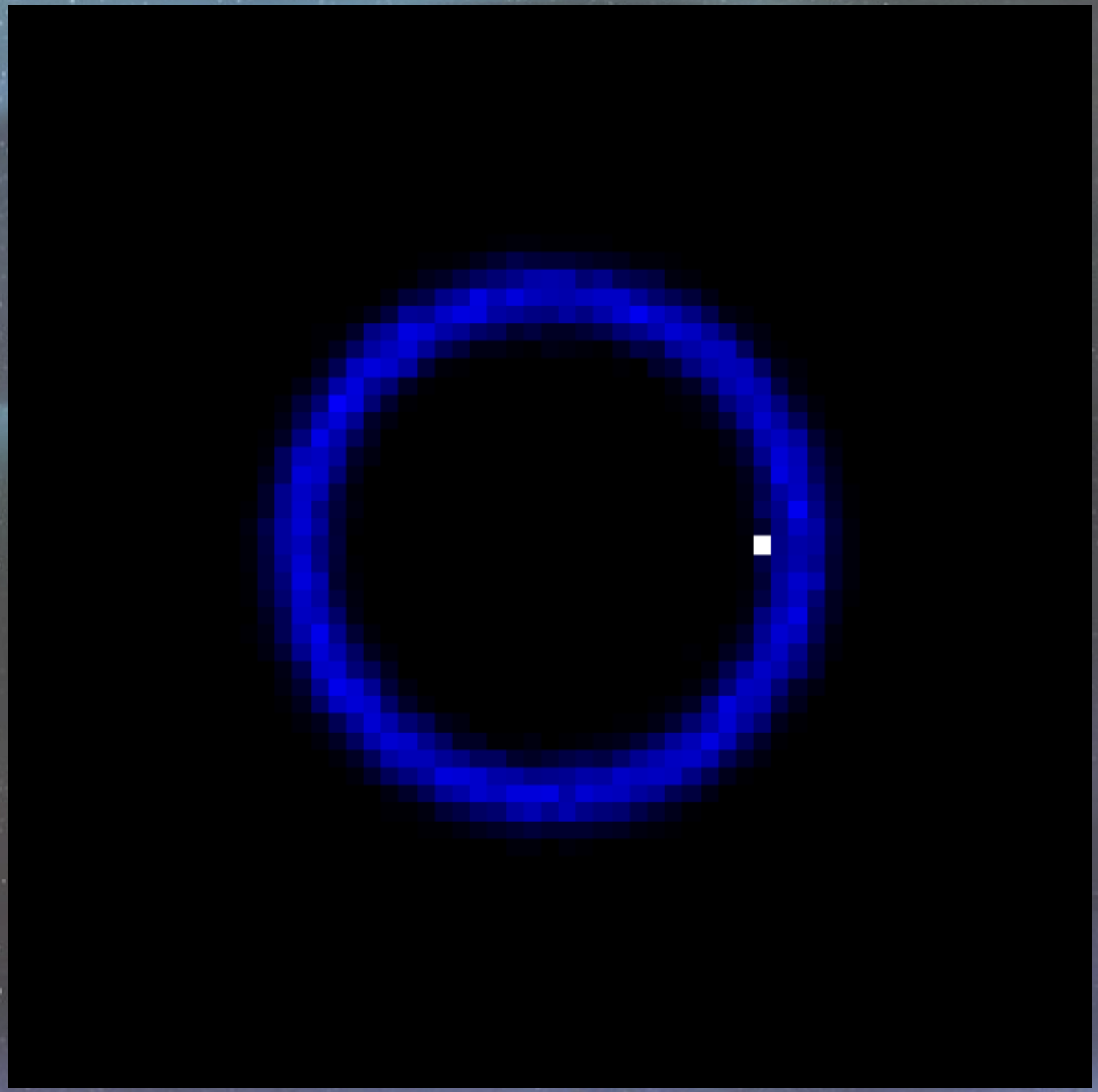


Douglas et al., (2022)



Anche et al., (2023)

V=5 star
$3x10^{-9}$ Companion at 2.5 AU
5 Zodi disk at 3 AU



V=5 star
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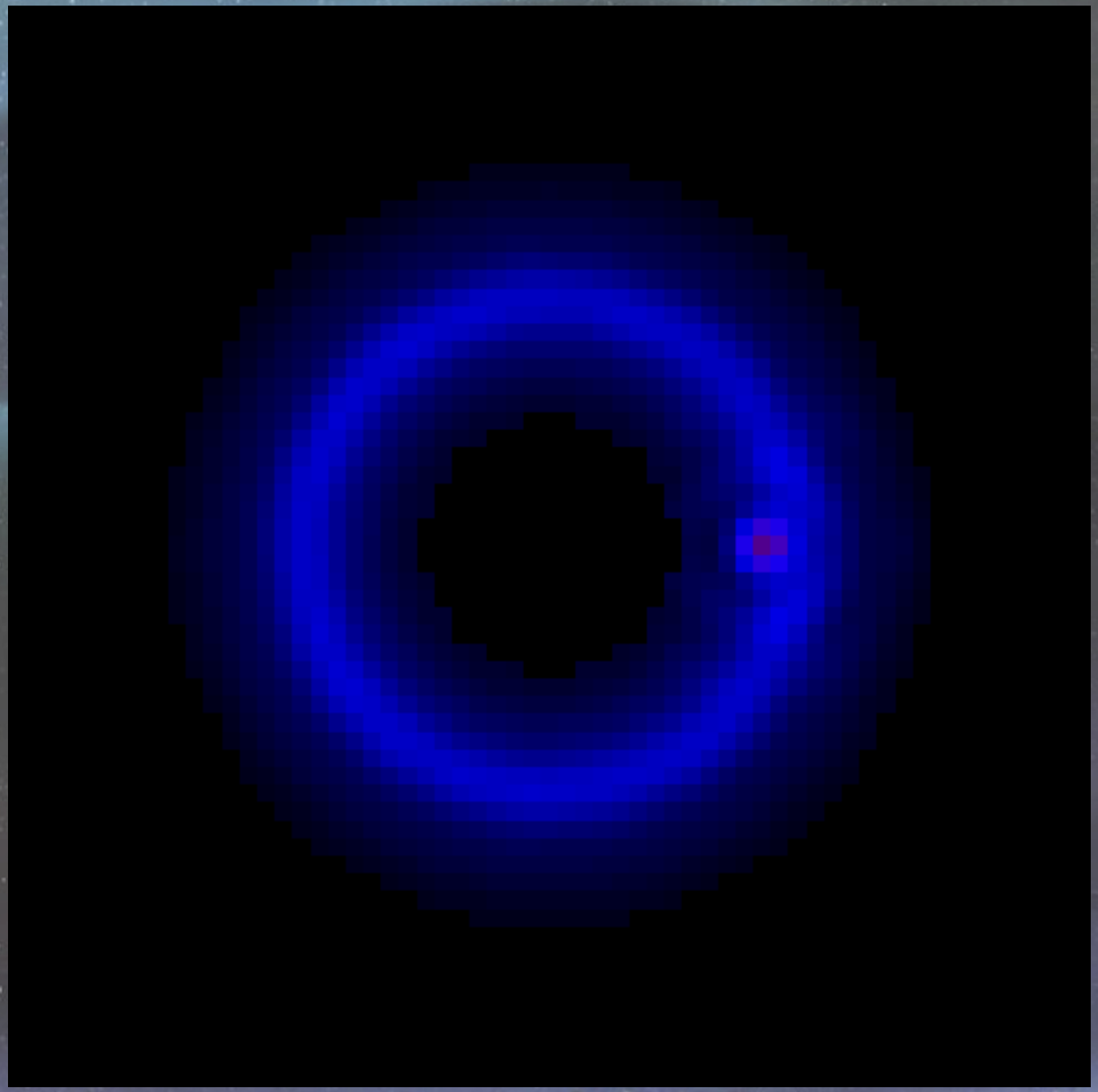
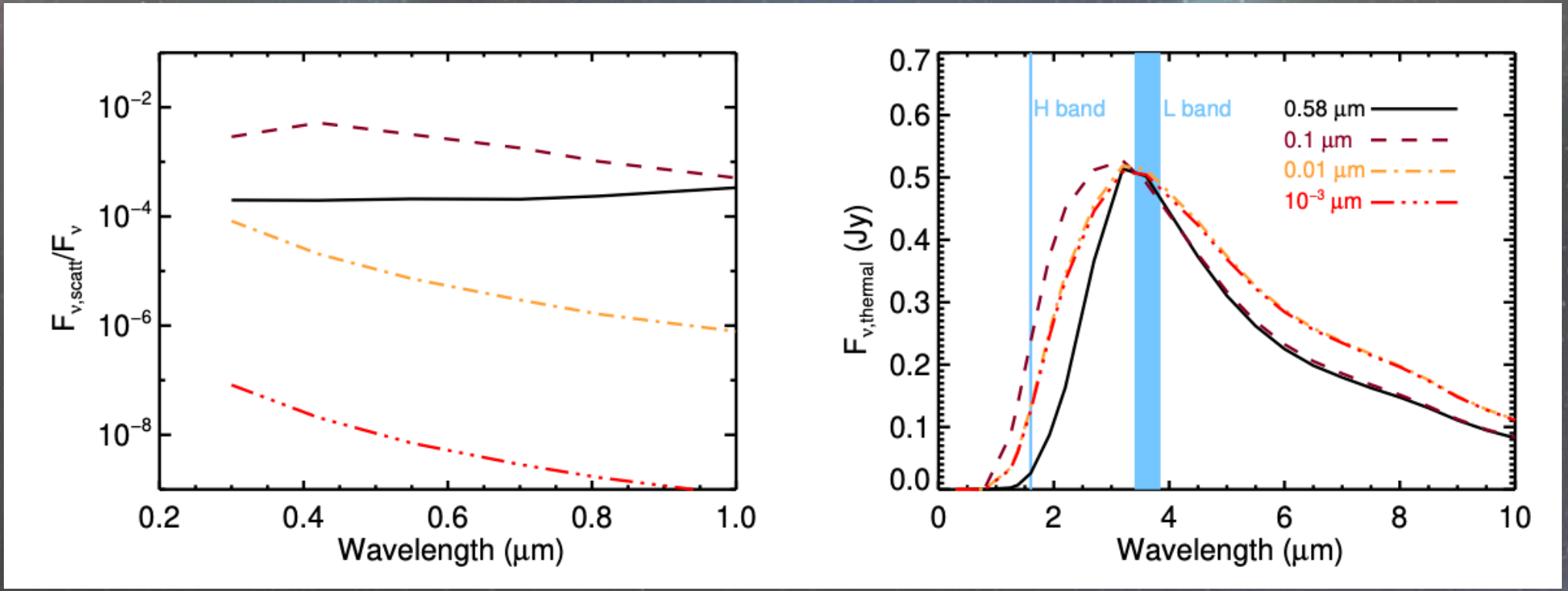
CGI PSF



Hot Dust implications for Direct Imaging



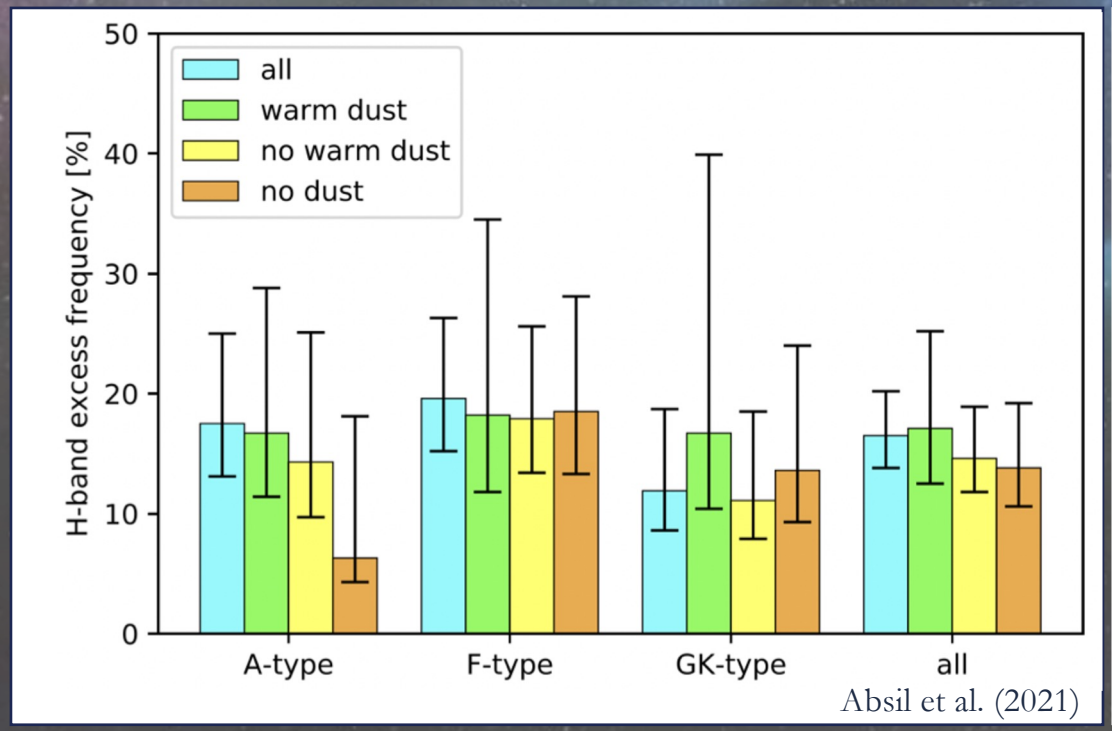
Using the preferred dust grain model and location from Kirschlager et al., 2020:

R= 0.3 au; r_{dust}= 10^{-3}-0.58 μm;

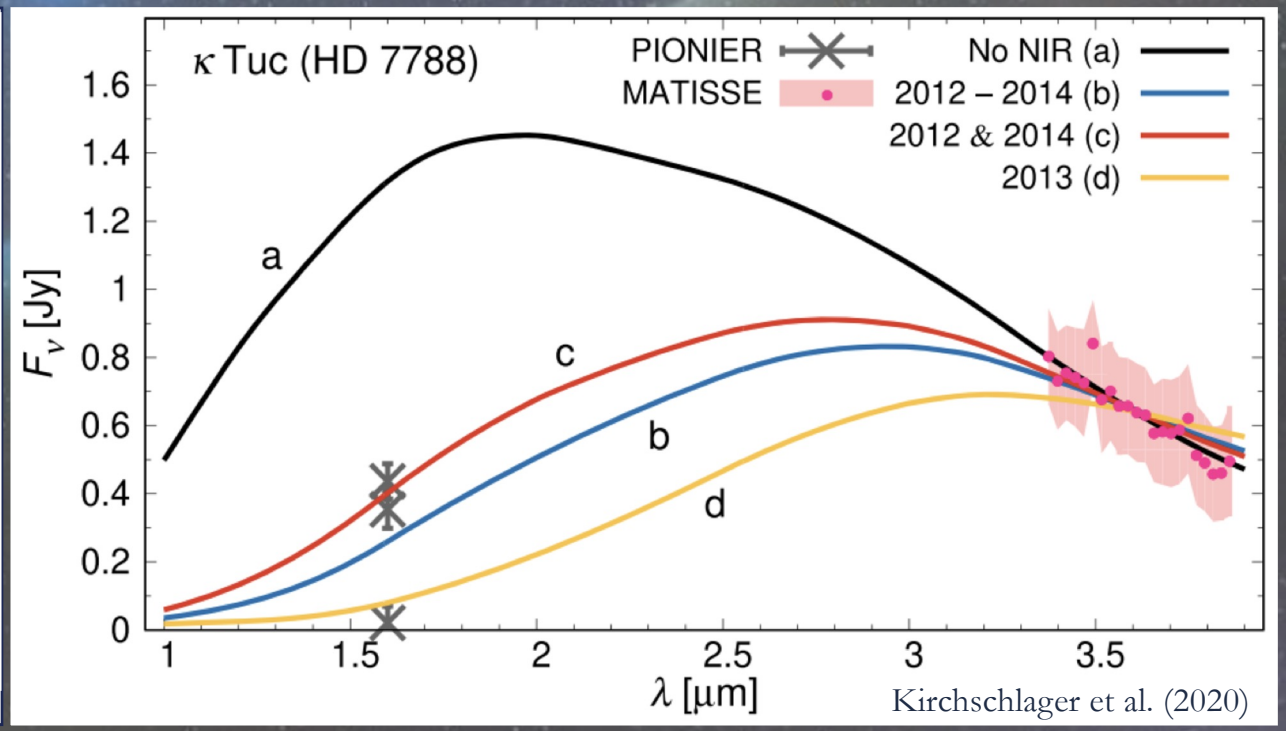
Use MCFOST to predict integrated scattered light relative to the star at wavelengths of relevance to HWO

Barely resolved hot dust at ~λ/D for HWO with contrast as much as 0.1% of the star

Hot Dust Implications for Direct Imaging



Absil et al. (2021)



Kirchschlager et al. (2020)

Hot dust is detected around ~20% of MS stars, repeatedly confirmed, it is real

So far no good understanding of its origin, formation, properties

Plausibly a significant risk to exo-Earth imaging from supply scenarios & coronagraph leakage

Summary

- Debris disks are the remnants of planet formation—they trace the planetary architectures of nearby stars, from rocky bodies to icy giants
- Their location, composition, and behavior under various forces tell us about the dust, their origins, and their evolution
- They are both the direct imager’s trash, treasure, and unexpected surprise-they obscure and reveal planets in different ways