

ALMA -JWST Synergy:

Disk Structure and Chemistry in 2013

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Carnegie / DTM



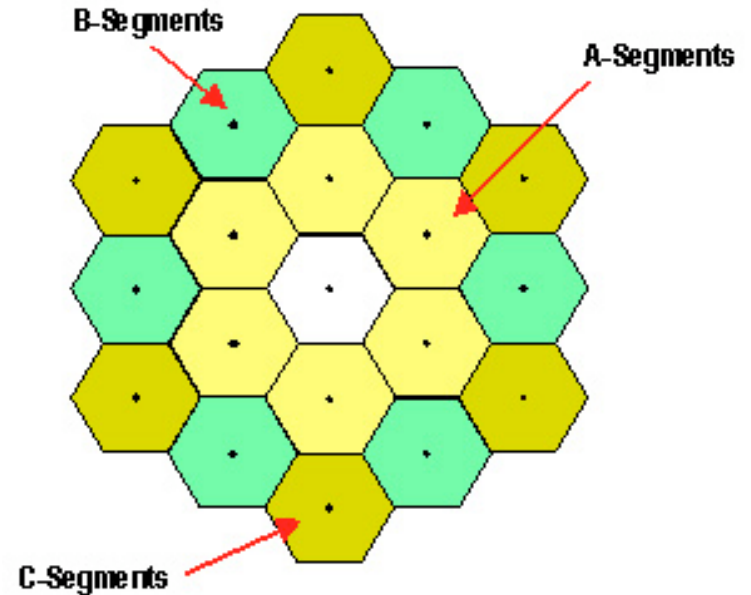
Some JWST Basics

❖ Telescope

- ❖ 18 Be Segments, Au coated
- ❖ 6.5 m diameter
- ❖ 150 K primary mirror temperature
- ❖ Located at L2

❖ 4 Science Instruments

- ❖ Fine Guidance Sensor - Tunable Filter Modules (FGS-TS)
- ❖ Near Infrared Camera (NIRCam)
- ❖ Near Infrared Spectrograph (NIRSpec)
- ❖ Mid Infrared Instrument (MIRI)



Launch: Scheduled for 2013

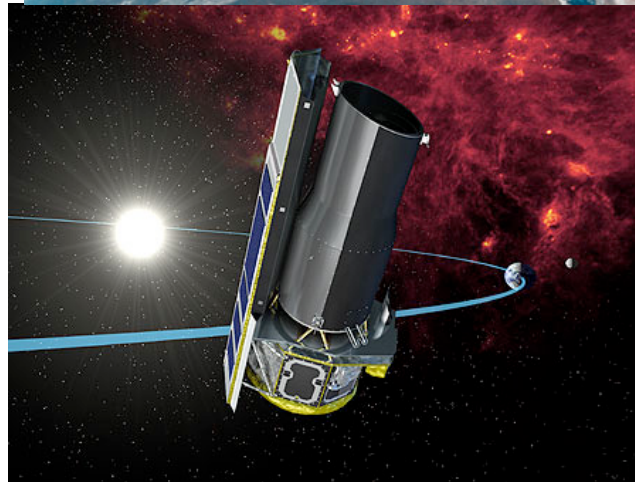


The Successor

HST

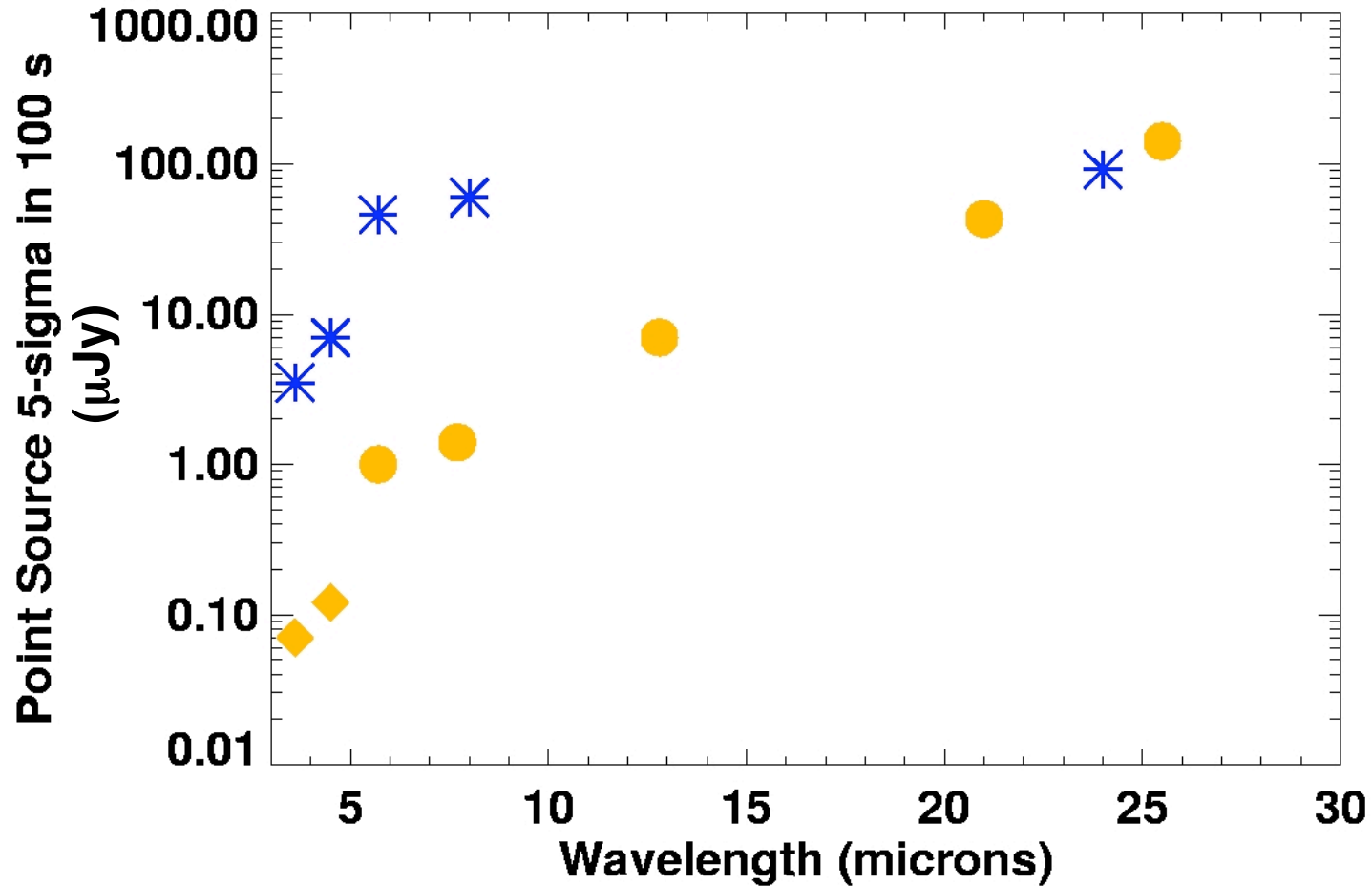


And
Spitzer





JWST-Spitzer Comparison



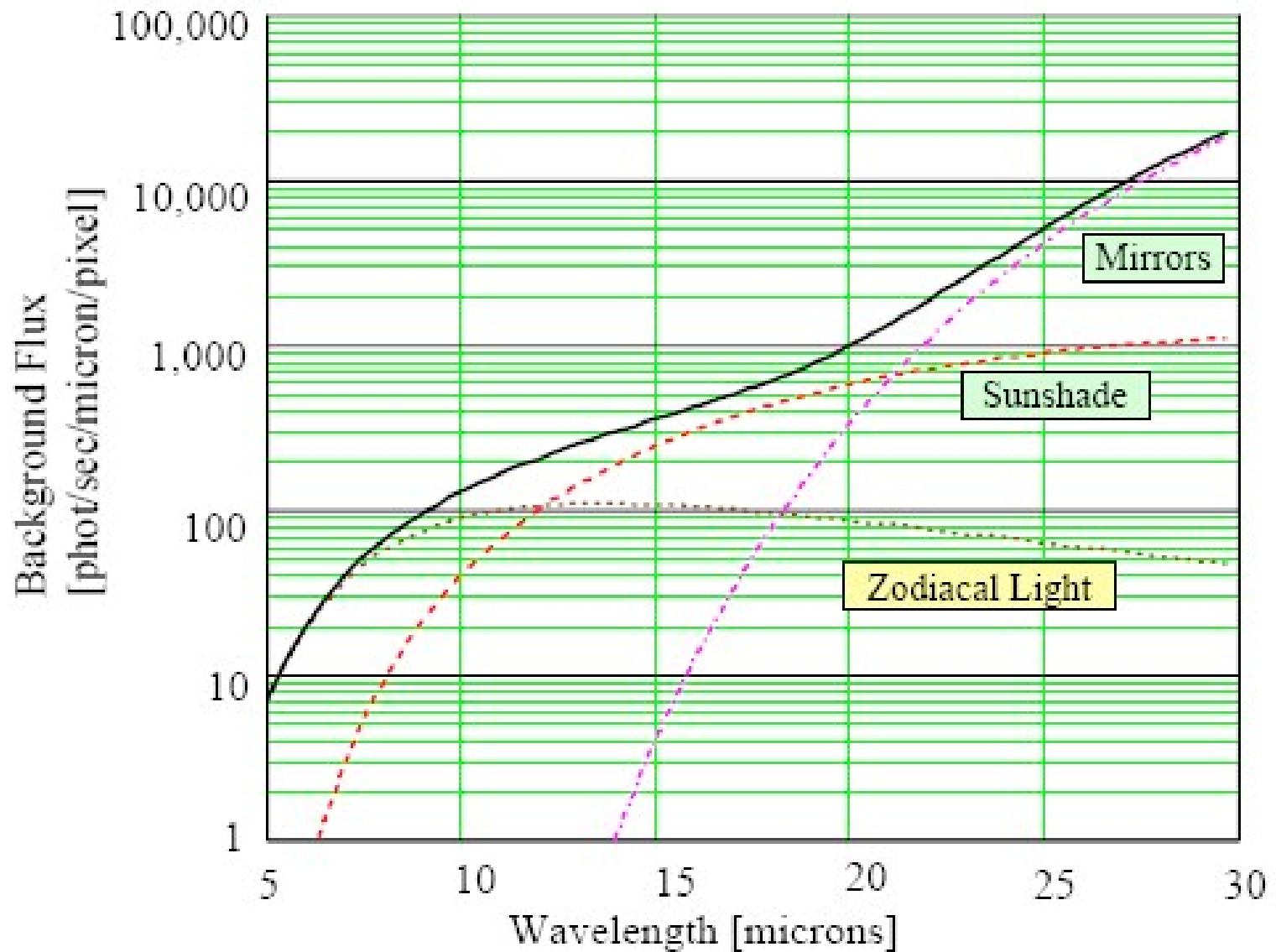
Beam Size at 8 μm :

*** Spitzer: 2"**

● JWST: 0.25"



MIRI Background



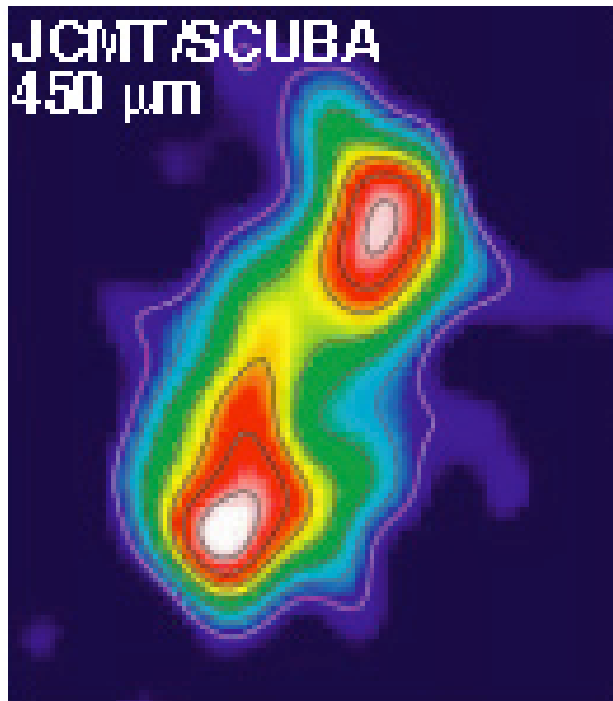


MIRI (<http://ircamera.as.arizona.edu/MIRI>)

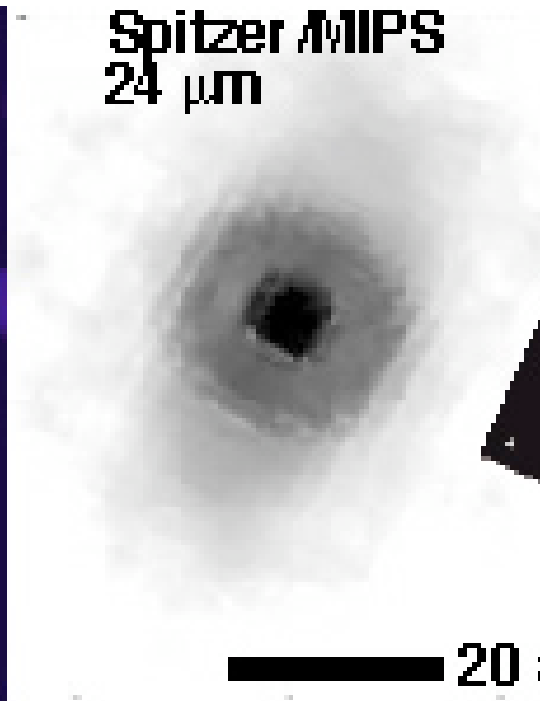
- ❖ Imaging 5-27 μm with 1.3x1.7' FOV
- ❖ Coronagraphs at 10.65, 11.4, 15.5, 23 μm

ALMA at 450 μm can be $< 0.1''$; JWST 24 μm resolution is $0.8''$

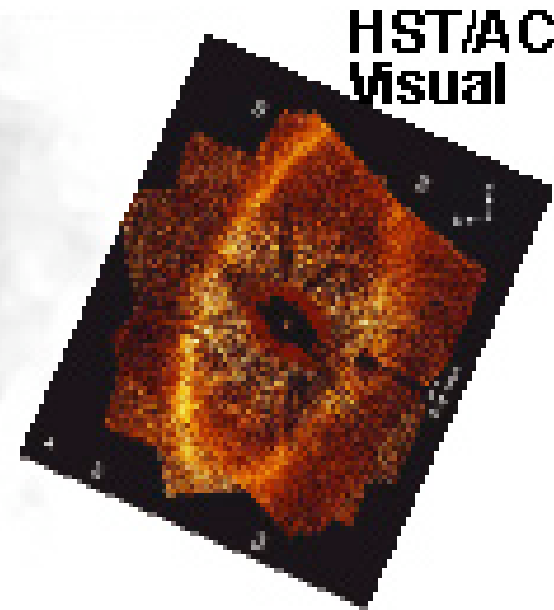
7.5'' resol.
Holland et al. 2003



5.8'' resol.
Stapelfeldt et al. 2003



0.05'' resol;
Kalas et al. 2005



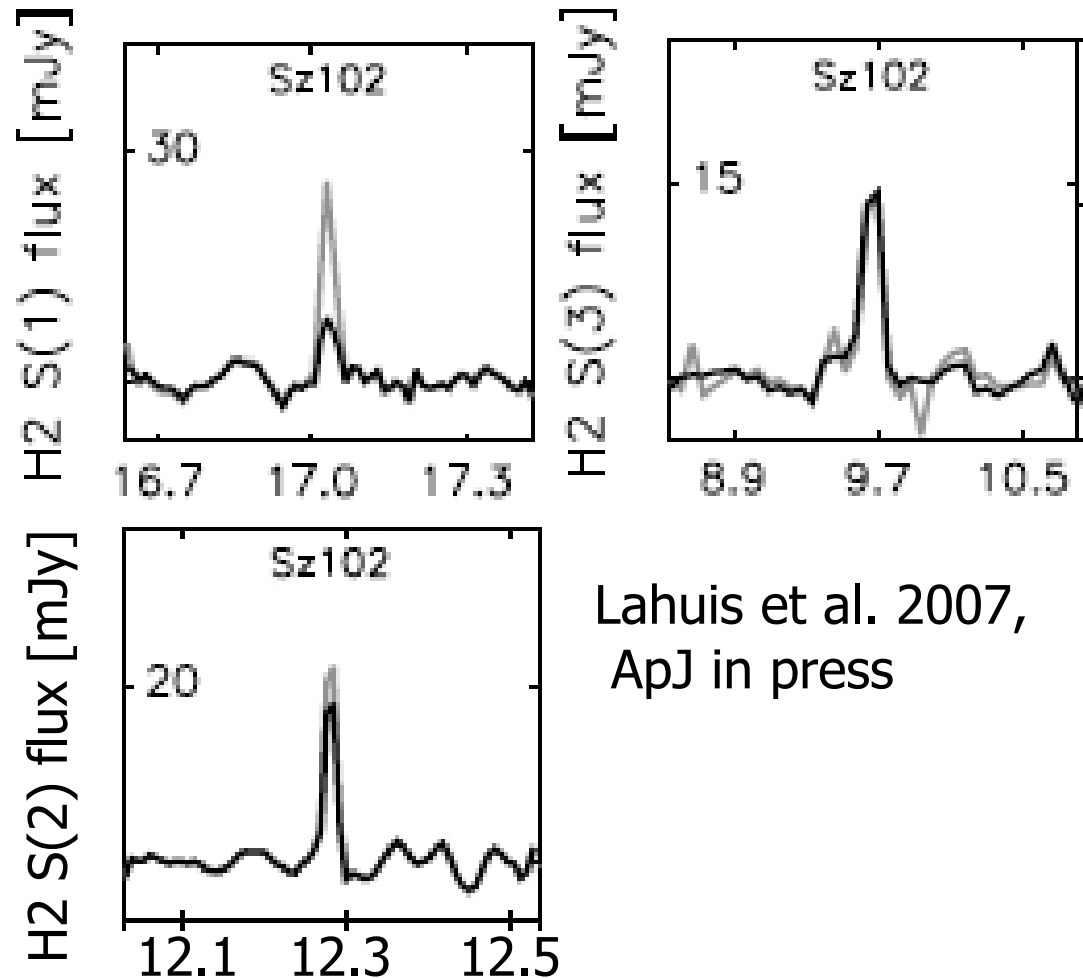
20 arcsec



MIRI Spectroscopy

- ❖ $R \sim 100$ at 5-10 μm
- ❖ $R \sim 3000$ 5-28.3 μm
(in 3 portions)

Track the CO:H₂ ratio
in disks over time



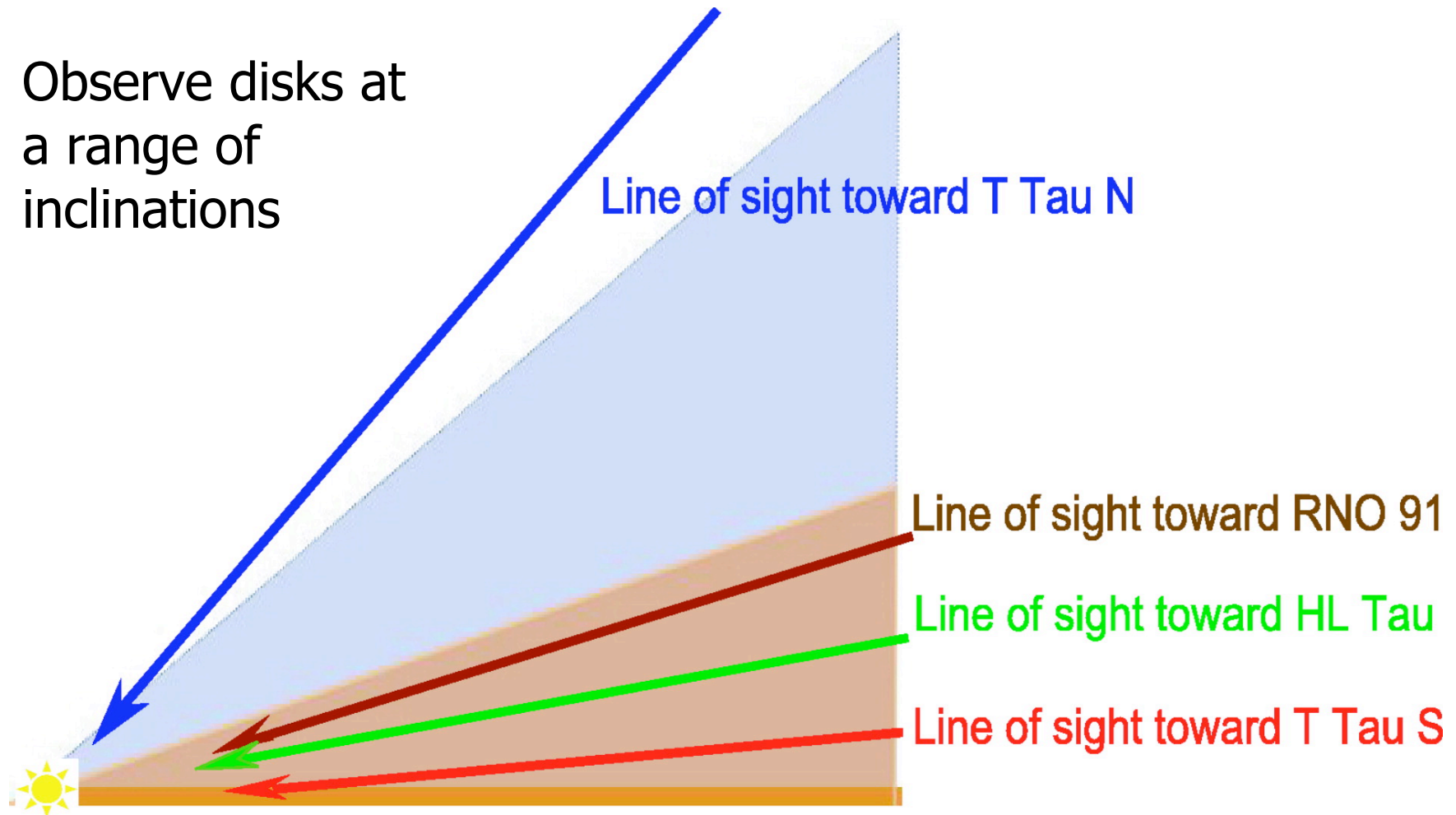
Lahuis et al. 2007,
ApJ in press

Note: Spitzer IRS has $R \sim 600$



Gas:Dust Statistically

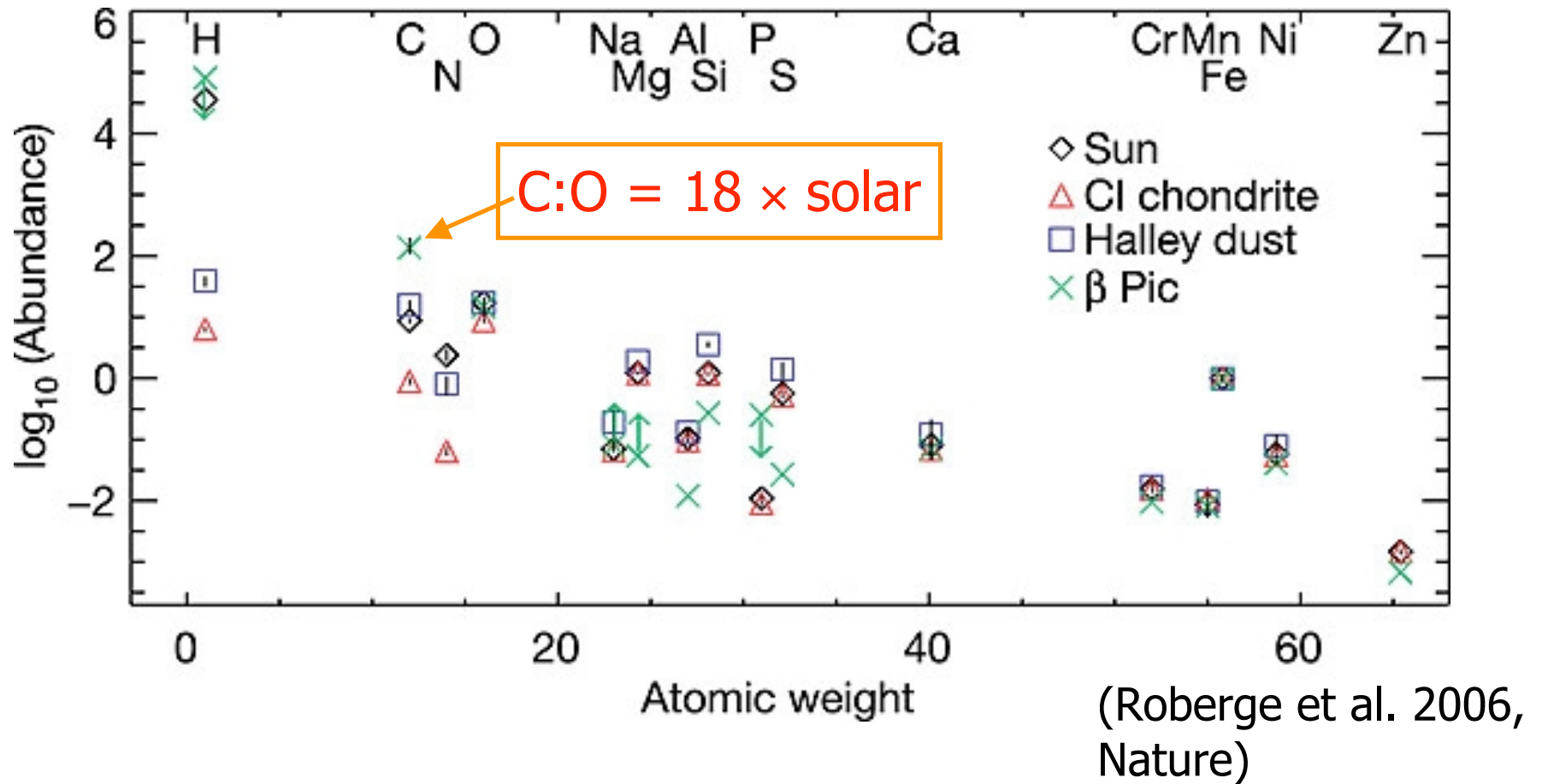
Observe disks at
a range of
inclinations



Rettig et al. 2006



Beta Pic Gas Composition

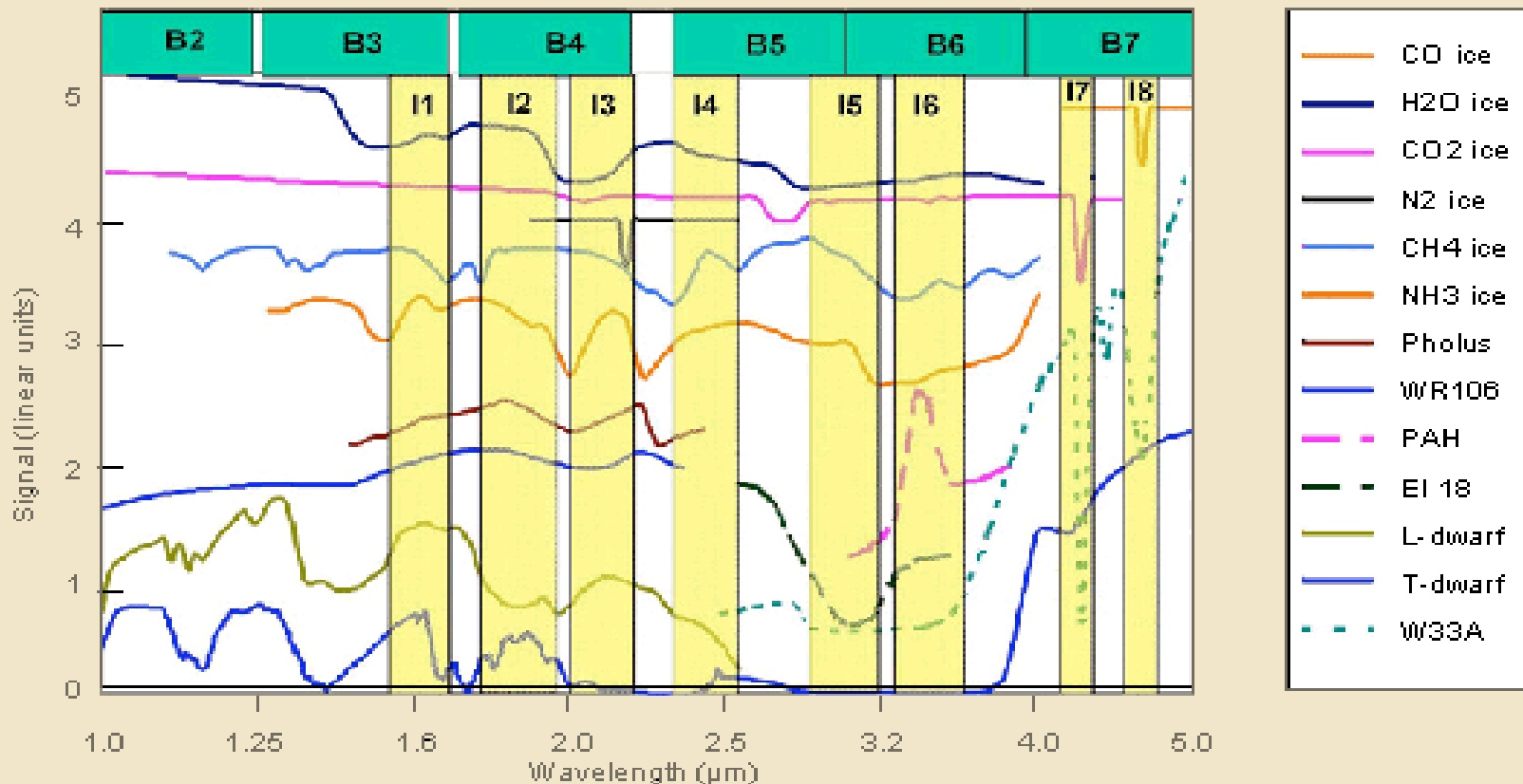


No Debris Disks have (yet) detections of submm gas emission



NIRCam (<http://ircamera.as.arizona.edu/nircam>)

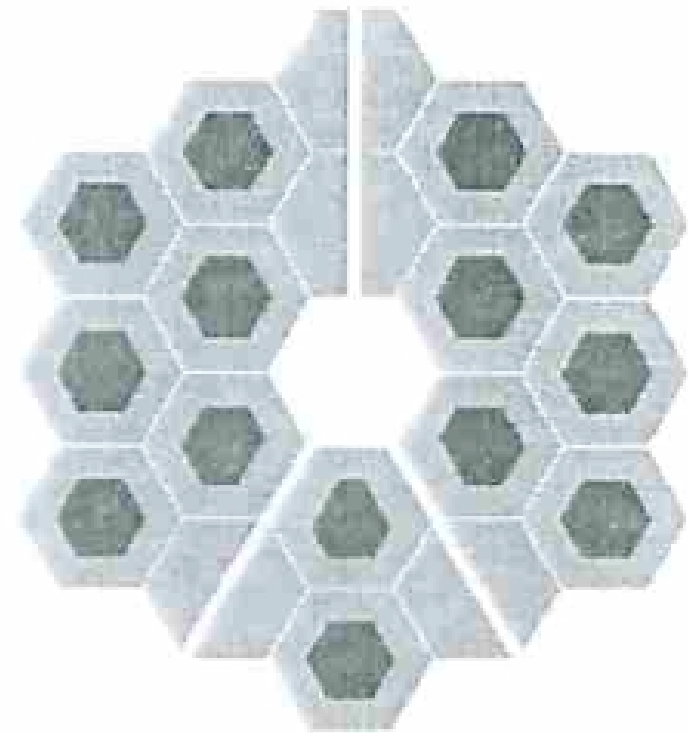
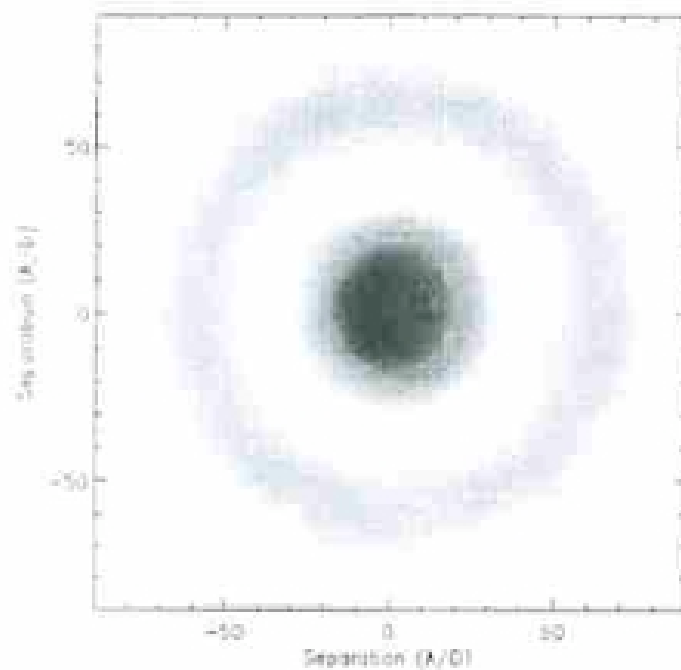
- ❖ Two Channels: 0.6-2.4 μm and 2.5-5 μm
- ❖ Nyquist sampled at 2 and 4 μm
- ❖ Field of View: 2.2 x 4.4 arcmin
- ❖ Coronagraphy





FGS-TFI

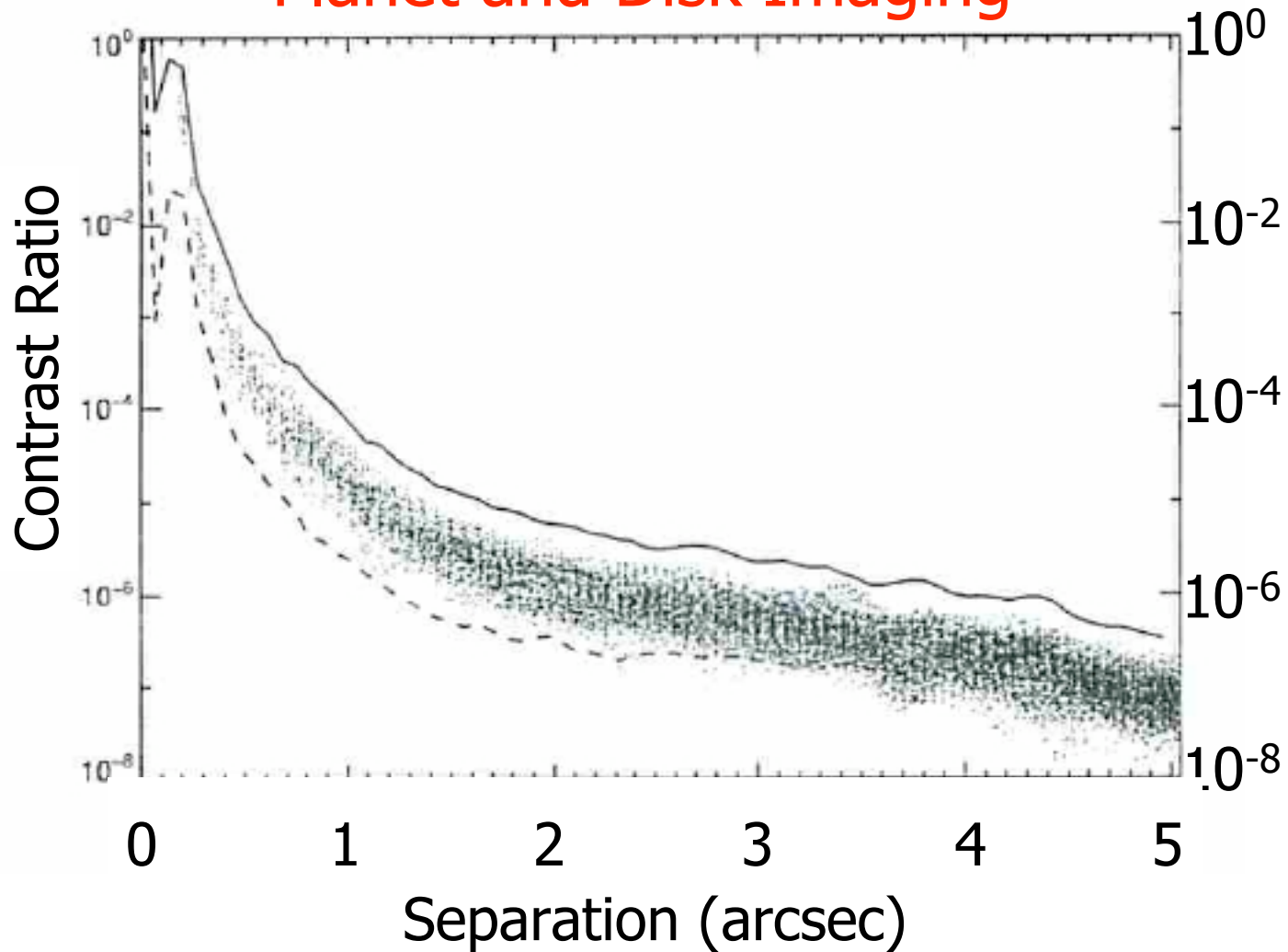
- ❖ 1.2 - 2.4 μm and 2.4 - 4.8 μm
- ❖ 2.2 x 2.2 arcmin FOV
- ❖ Selectable $R \sim 100$
- ❖ Coronagraphs for 20x20" FOV





FGS-TFI Contrast at $4.5\mu\text{m}$

Planet and Disk Imaging



Doyon et al. 2004



Contrast Similar to HST

HR 4796: NICMOS/STIS
Contrast $\sim 10^{-4}$ at $0.5''$

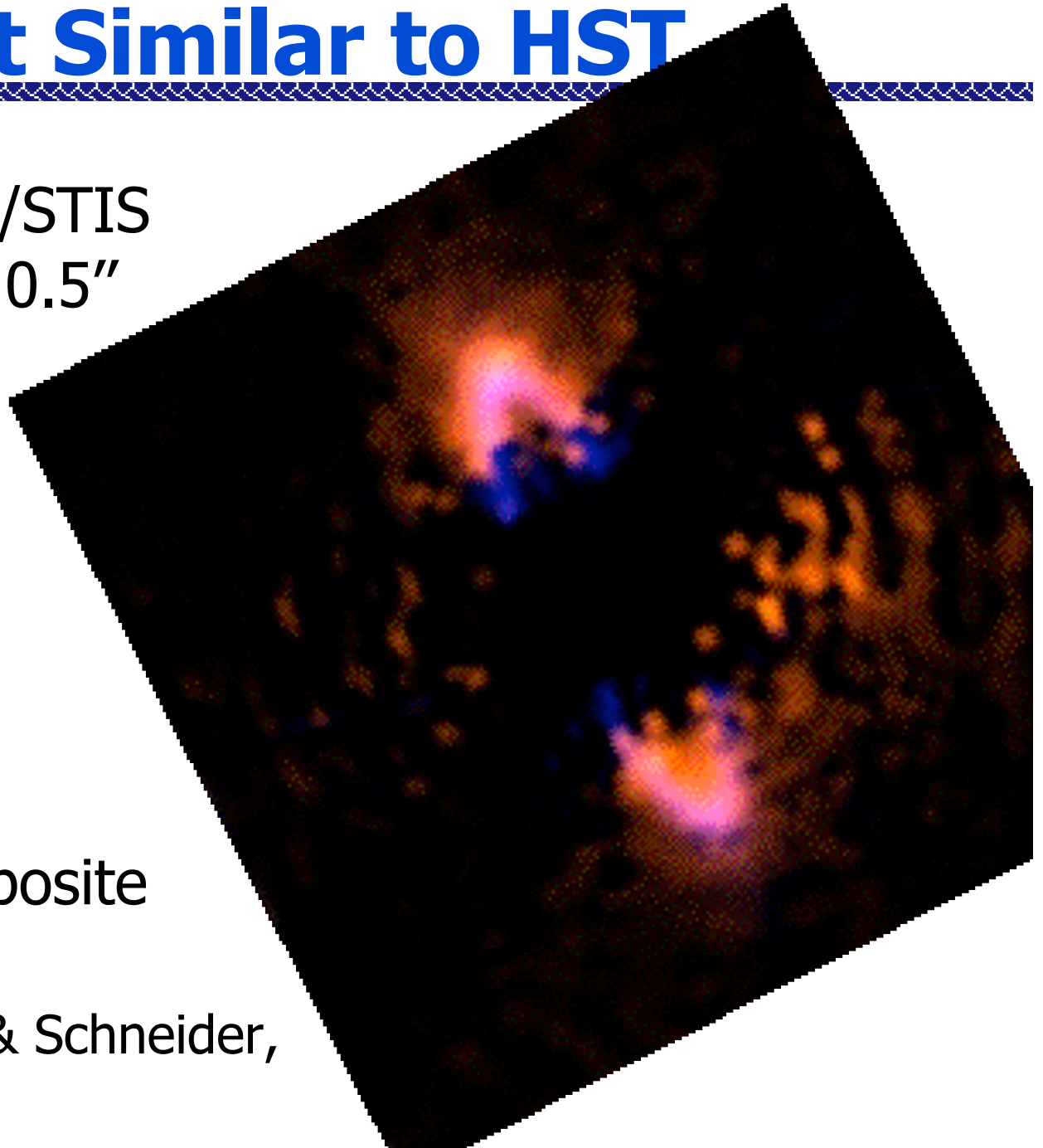
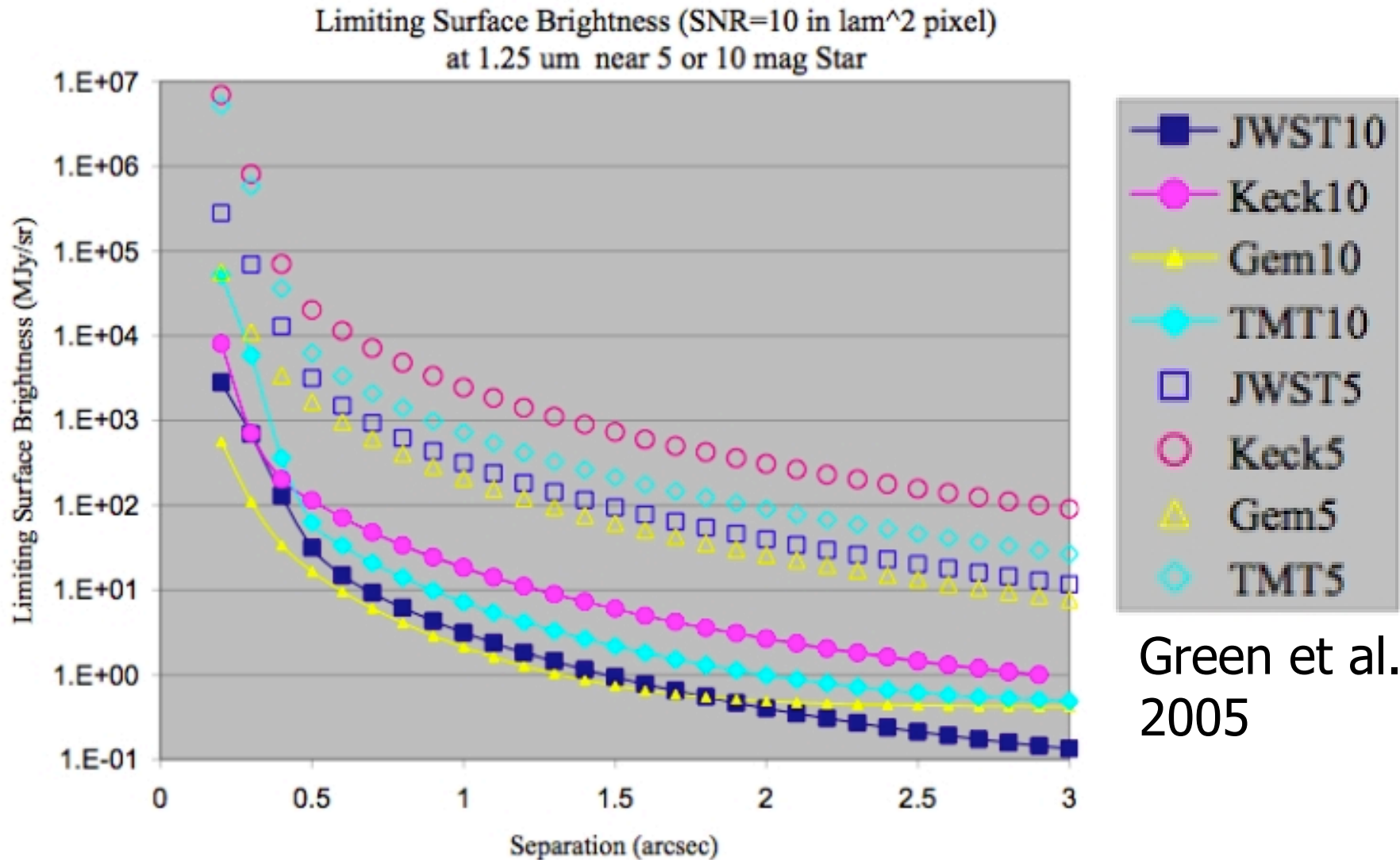


Image: Color composite
at $0.5 - 2.2 \mu\text{m}$
(Debes, Weinberger & Schneider,
in prep)



Imaging in Scattered Light

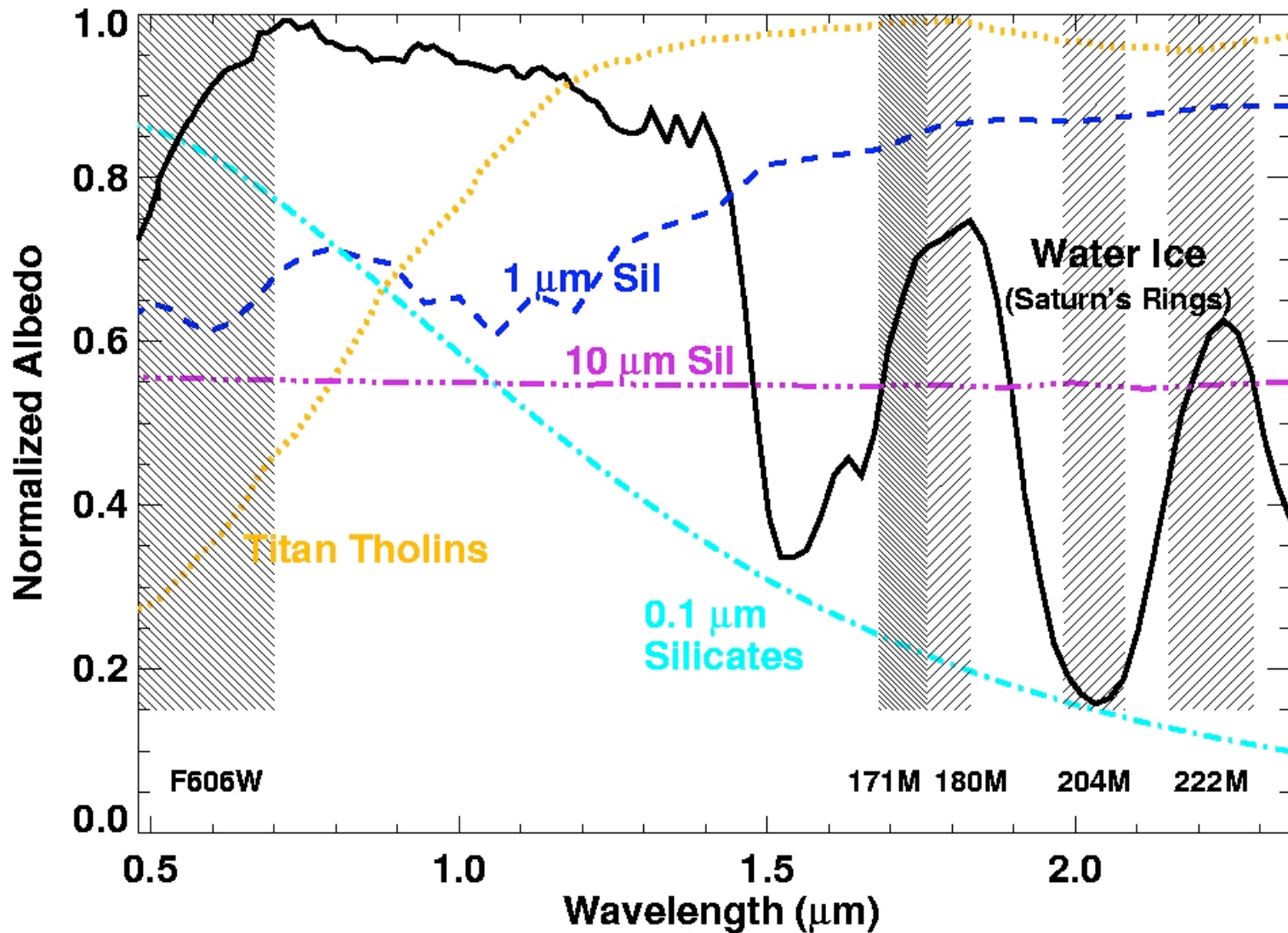
❖ Coronagraphy in FGS-TF and NIRCam



Green et al.
2005



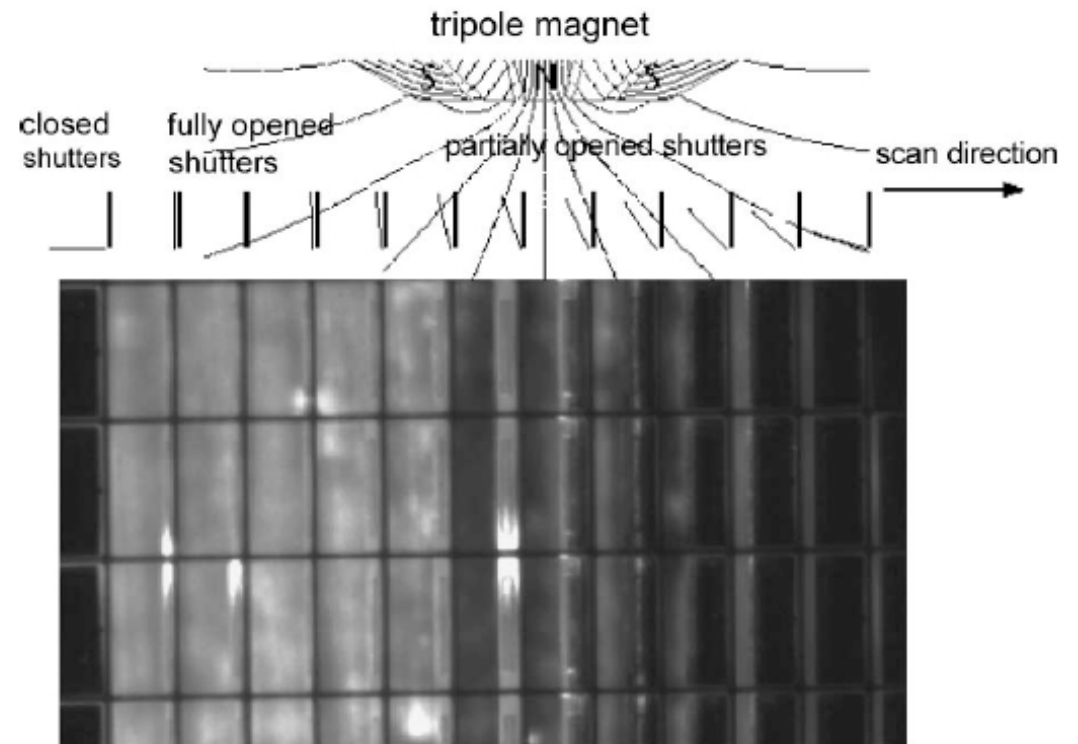
Scattering Albedo: Silicates, Ices and Organics





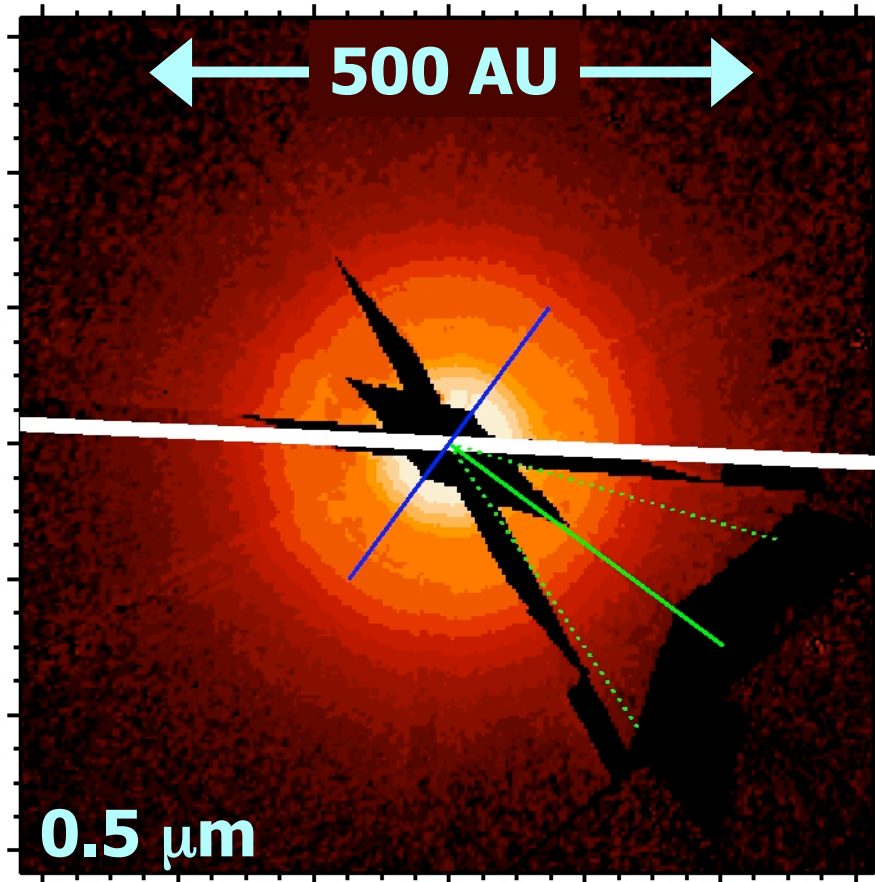
NIRSpec [\(http://www.stsci.edu/jwst/instruments/\)](http://www.stsci.edu/jwst/instruments/)

- ❖ 0.6 - 5 μm
- ❖ $R=100, 1000, 3000$
- ❖ FOV 3.4 x 3.4 arcmin
- ❖ Microshutter array
- ❖ Contrast
(open/closed) ~ 3000





TW Hya With HST



Roberge et al. 2005



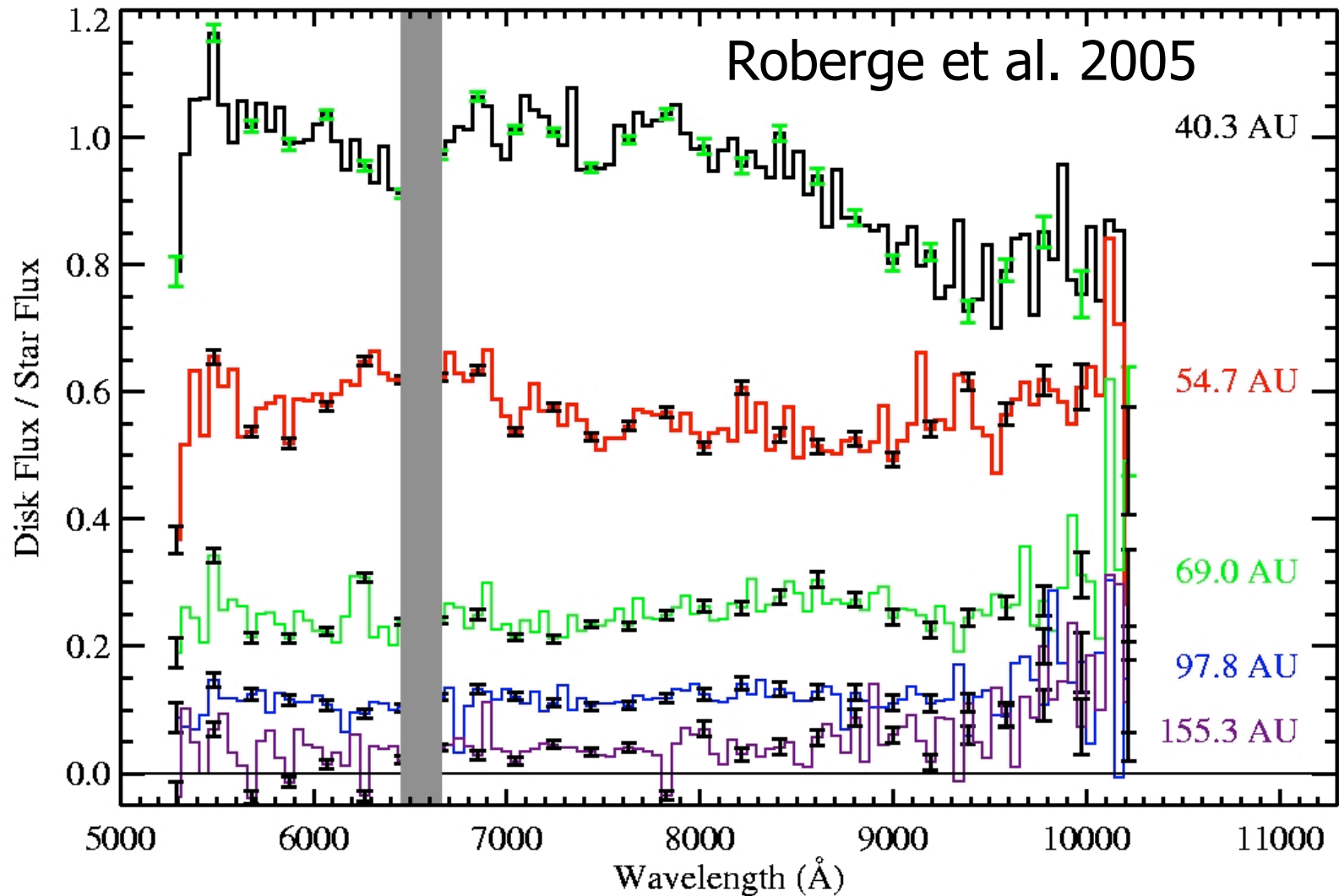
Debes et al. in prep

0.5 - 2 μm

**Color same as star: largeish grains, as expected
Inner Warp?**



Spatially Resolved Spectra



Blue color in inner-most disk: collision dominated?



My Combo Wish List

- ❖ Spatially resolved gas:dust ratios and depletion in transitional disks
- ❖ Prevalence of organics on surfaces and in gas phase of disks
- ❖ Ice lines; volatile gradients in disks
- ❖ Disk morphologies and evidence for planets



More about JWST

Space Science Reviews Paper on JWST
Capabilities by Gardner et al.:

<http://arxiv.org/abs/astro-ph/0606175>

Space Telescope Science Institute JWST Site:
<http://jwstsite.stsci.edu/>