

# Early ALMA Observations of Circumstellar Disks



North American ALMA Science Center

A. Meredith Hughes, UC Berkeley

Atacama Large Millimeter/submillimeter Array  
Expanded Very Large Array  
Robert C. Byrd Green Bank Telescope  
Very Large Baseline Array



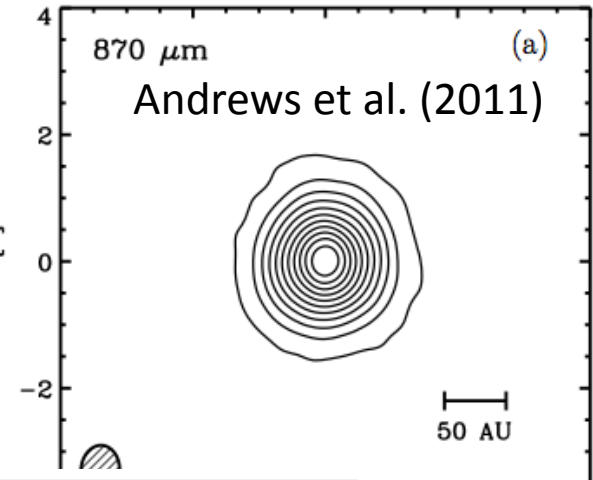
# Overview of ALMA disks so far

- **Science Verification: TW Hya**  
Suggested by 7 people for science verification, data released in bands 3, 6, 7
- **Cycle 0: Fomalhaut**  
PI Aaron Boley
- **These results already showcase some of ALMA's extraordinary science potential**  
(and they're not paying me to say that!)
- **There is a lot more amazing data from Cycle 0 about to be released...**

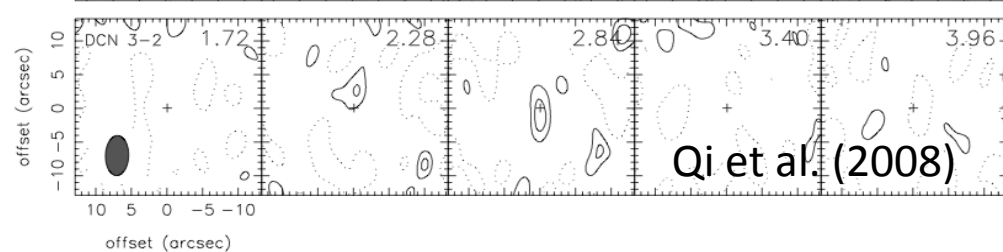
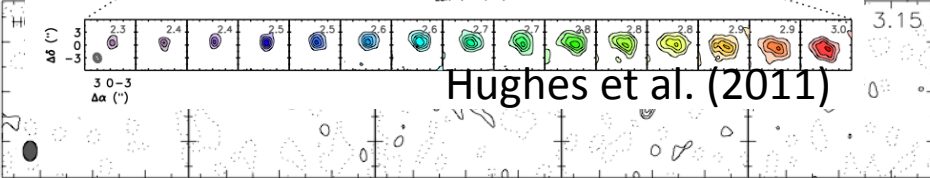
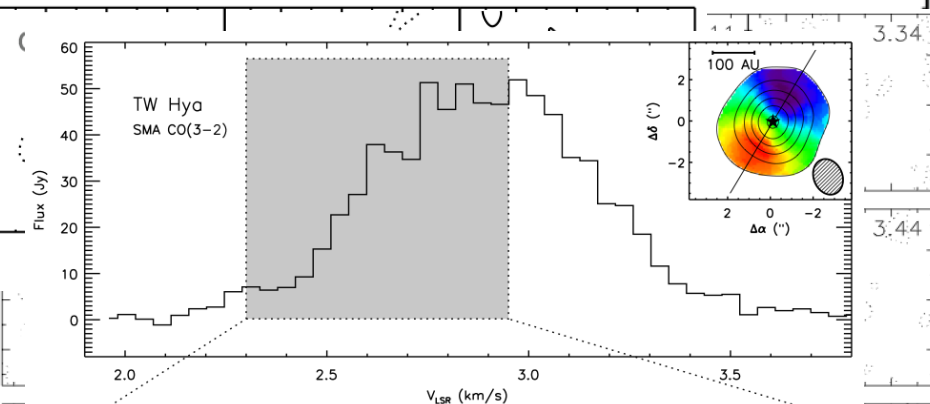
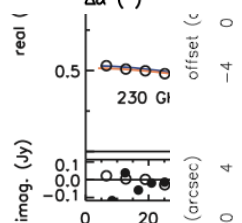
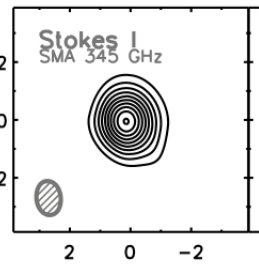
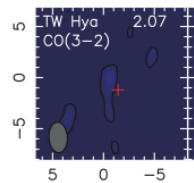


# TW Hya Background

- Closest known gas-rich disk (51 pc)  
Southern hemisphere, observed to death with the SMA
- Bright, isolated, seen nearly face-on



Dust  
Gas  
(Dust & Gas)  
CO transitions  
More molecules  
Polarimetry  
High spectral resolution

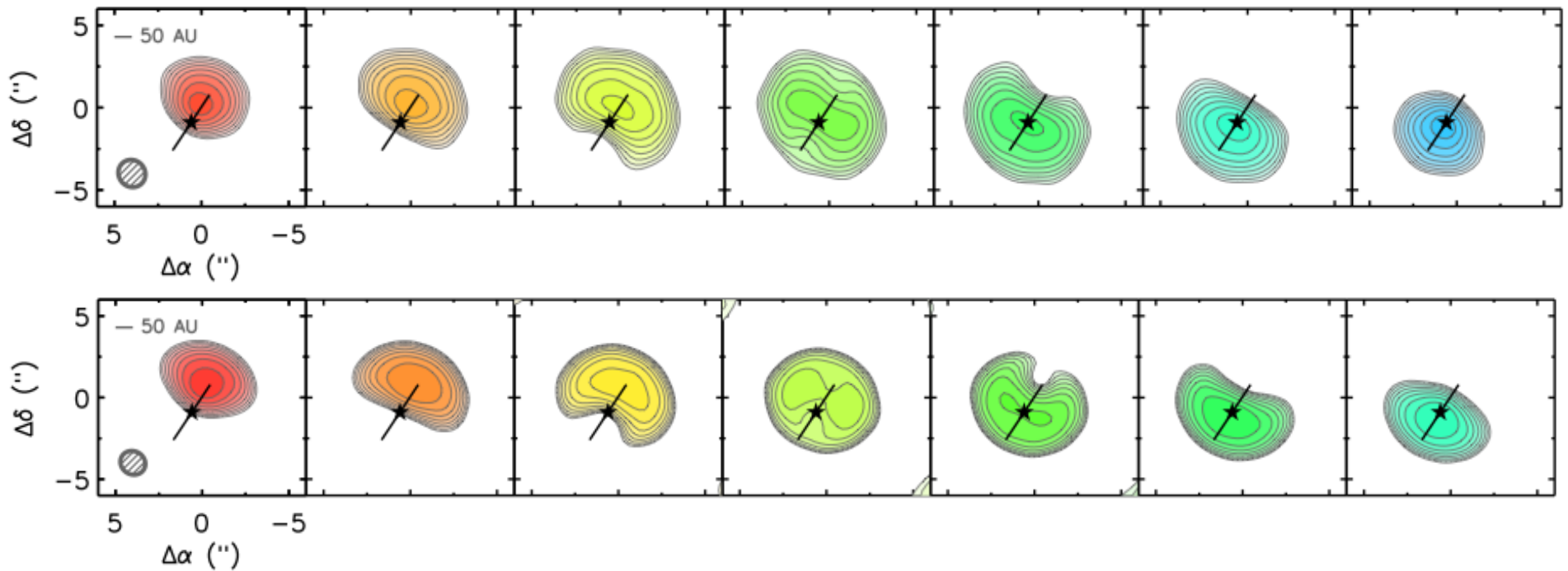


(etc.)



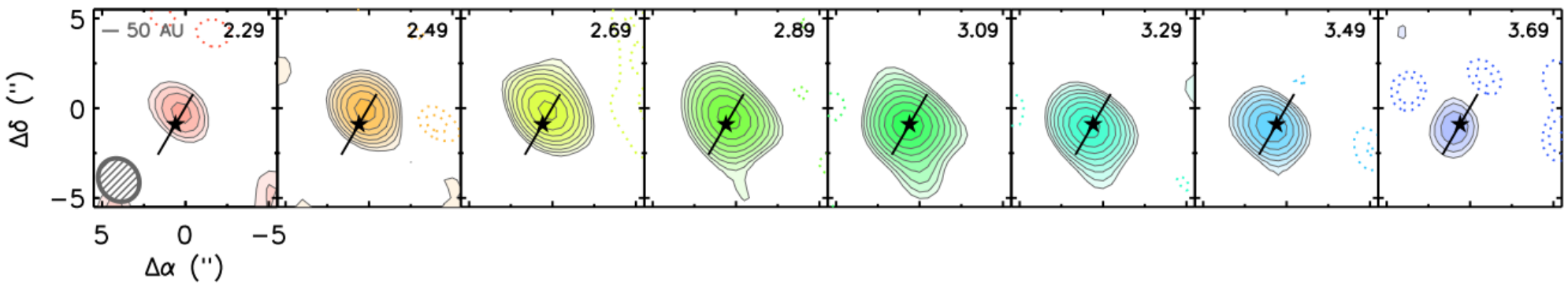
# TW Hya CO J=3-2

- Data/model comparison – can you tell the difference?



# TW Hya DCN

- Fine structure in a deuterated, nitrogen-bearing, triatomic molecule(!!!)



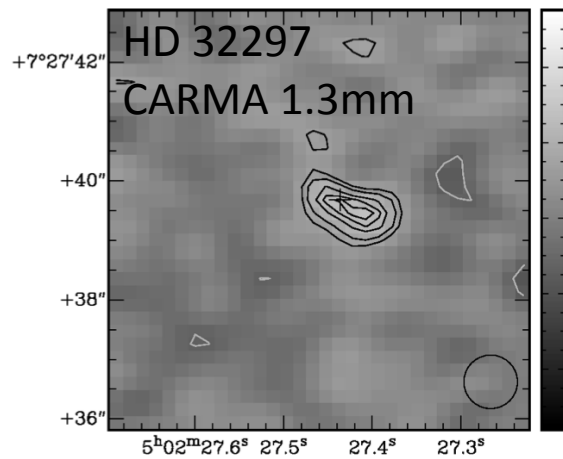
Thanks to C. Qi

Already exciting science: evidence for multiple pathways to deuterium enhancement in protoplanetary disks (Oberg et al., ApJ, submitted)

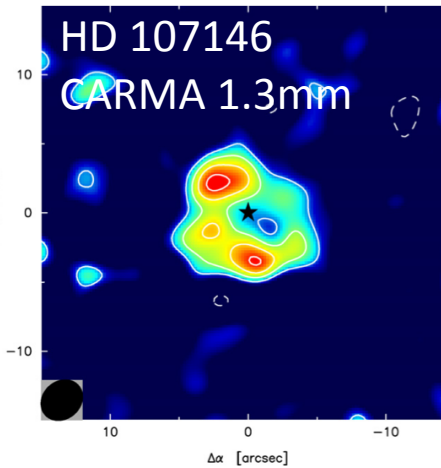


# Fomalhaut Background

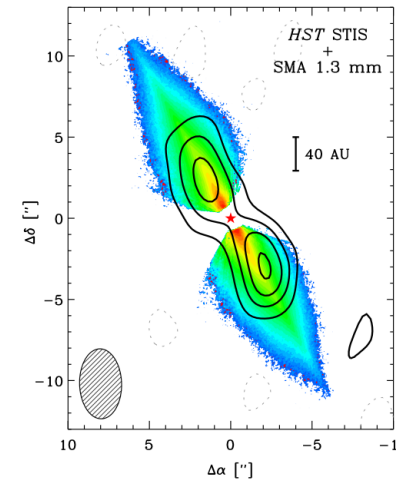
- Context: mm-wavelength interferometry of debris disks so far...



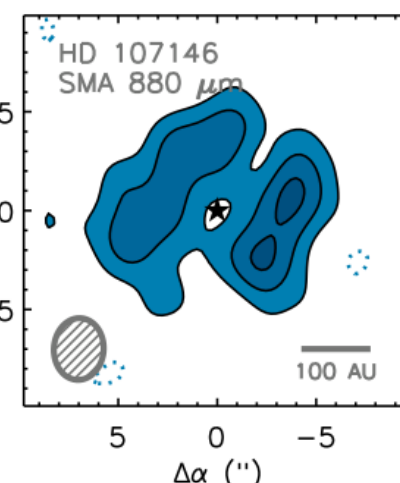
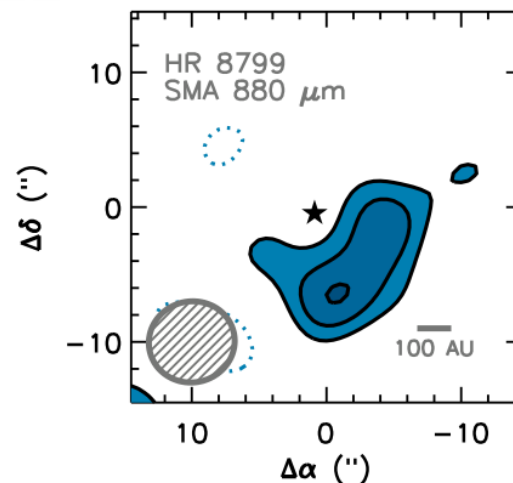
Maness et al. (2008)



Corder et al. (2009)



Wilner et al. (2011)



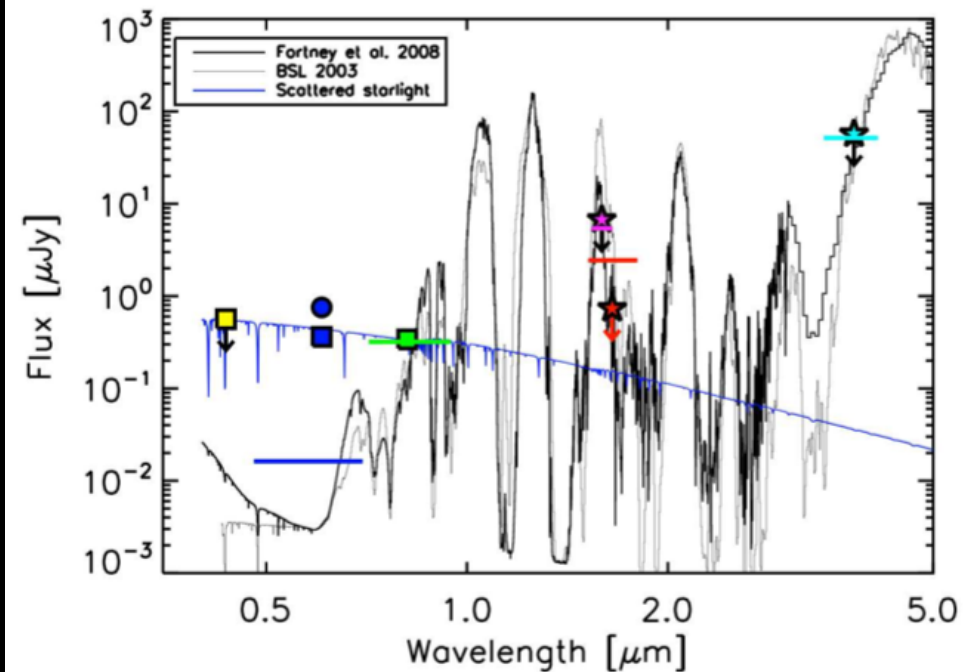
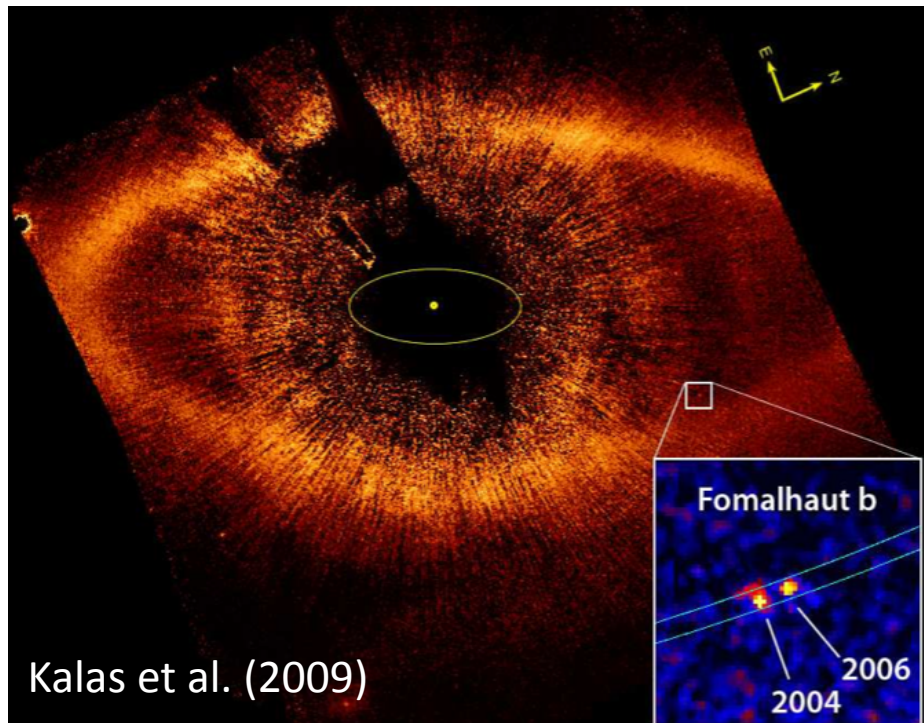
Hughes et al. (2011)



# Fomalhaut Background

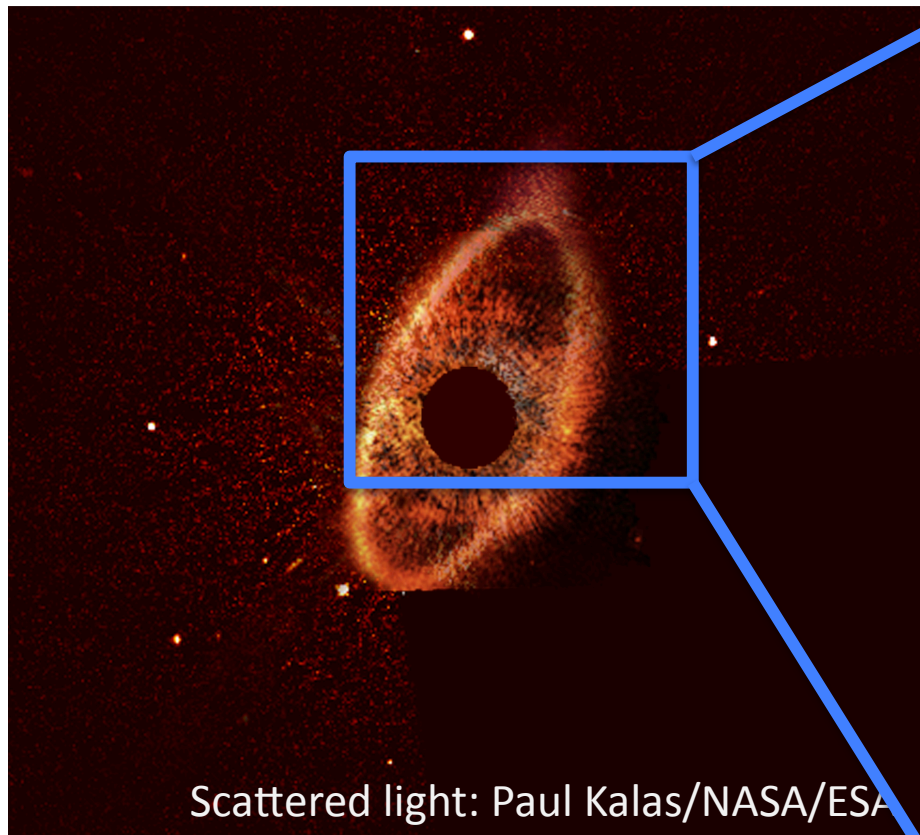
- Context: mm-wavelength interferometry of debris disks so far...
- Fomalhaut: one of three directly-imaged planetary systems with a debris disk

Possible circumplanetary disk!



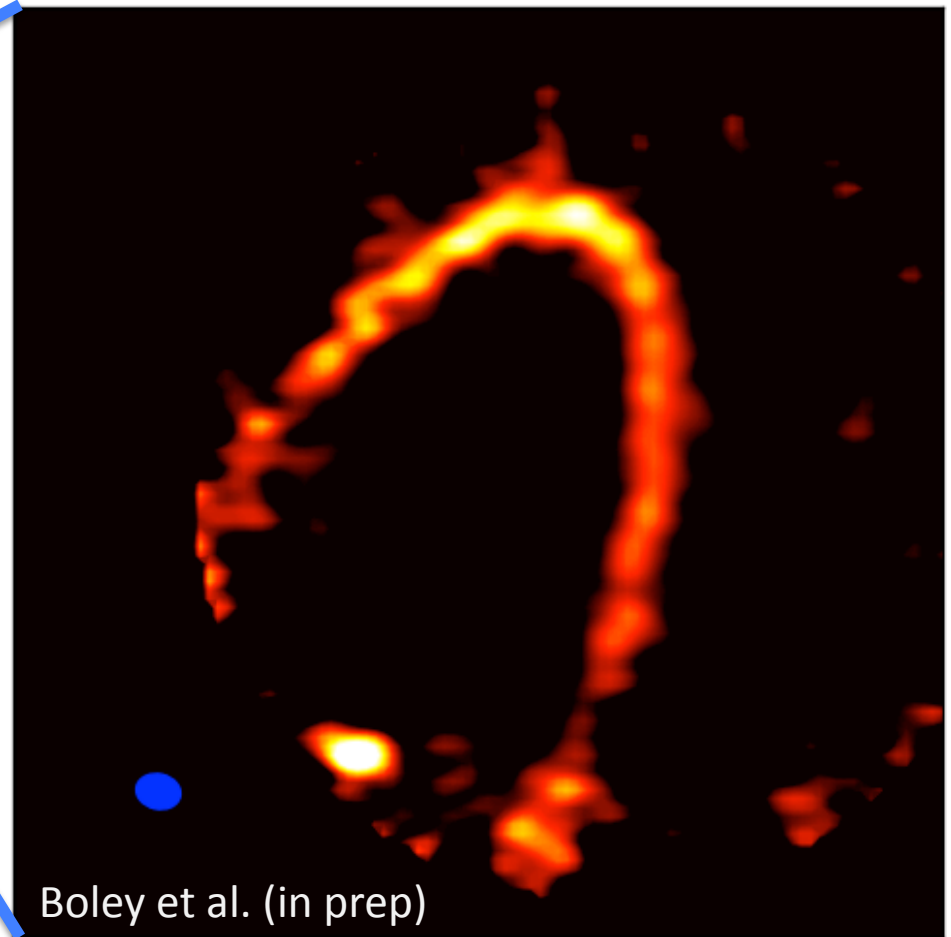
# Fomalhaut Observations (PI: Boley)

Fomalhaut



(Three hours of data) →

(Holy cow)

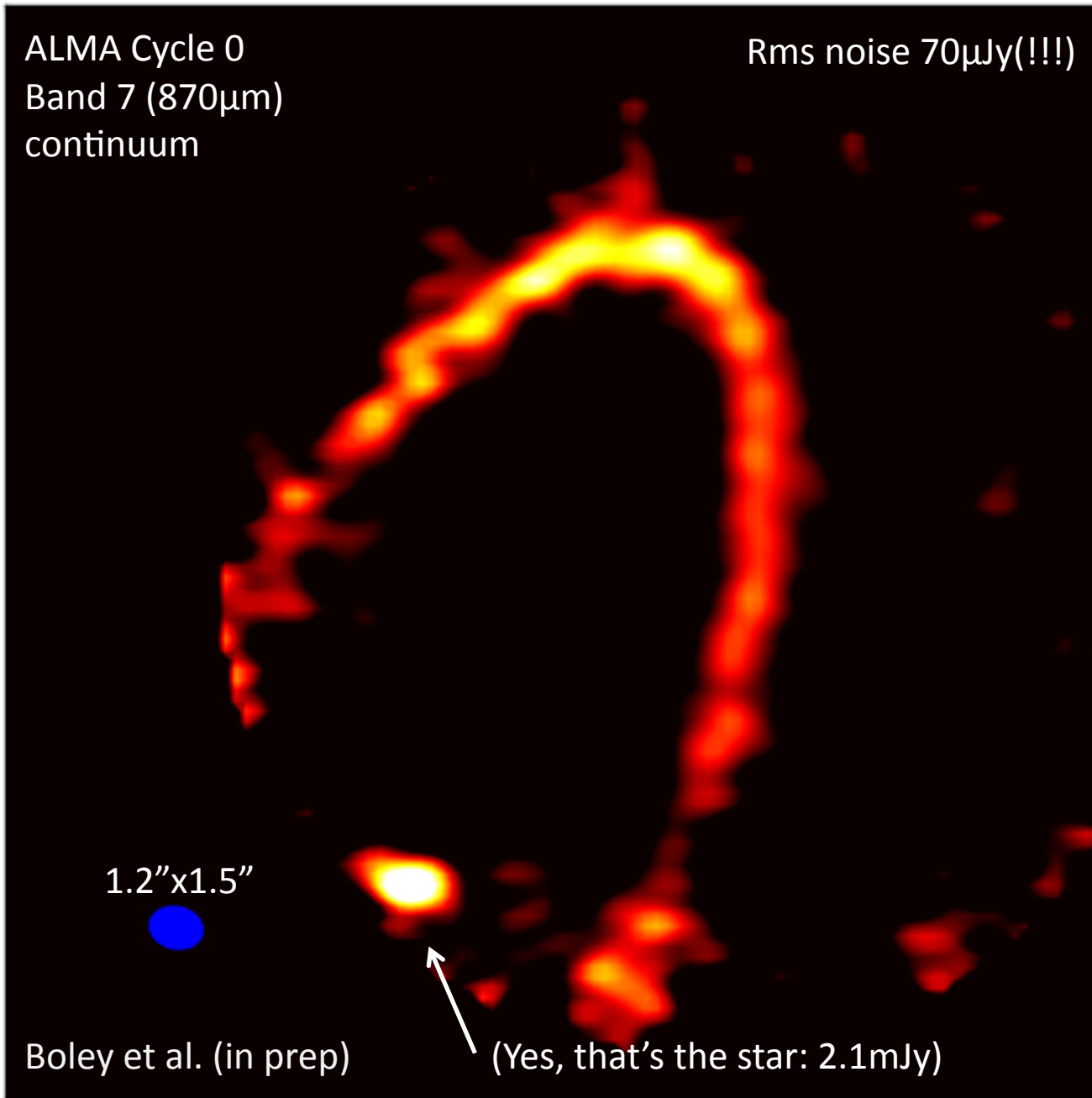




# Fomalhaut

ALMA Cycle 0  
Band 7 (870 $\mu$ m)  
continuum

Rms noise 70 $\mu$ Jy(!!!)



~30 Arcsec

# Coming soon from Cycle 0...

- Young disks (Orion proplyds, brown dwarfs, binaries, chemistry, winds, gas/dust structure, dynamics)  
Pls: Mann, Akeson, Ricci, Qi, Lin, Carpenter, Salyk, Chapillon, Walsh
- Old disks (debris, birth rings, Herschel cold disks)  
Pls: Rodriguez, Jordan, Carpenter, Boley, Wilner, Woitke
- In-between disks (gas-poor/dust-rich, gas-rich/dust-poor, gas in cavities, dust in cavities, unusually small/large disks)  
Pls: Dutrey, Andrews, Chapillon, Casassus, van Dishoek, Perez, Schreiber, Kospal
- Planet-disk interaction  
Pls: Jordan, Huelamo, Boley

