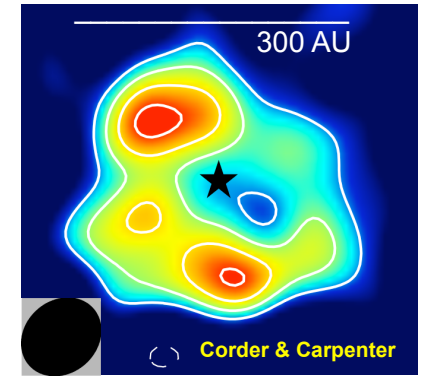
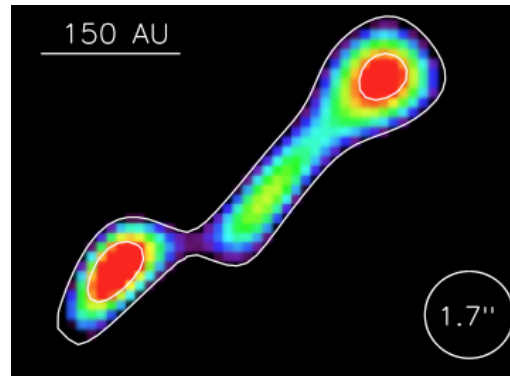
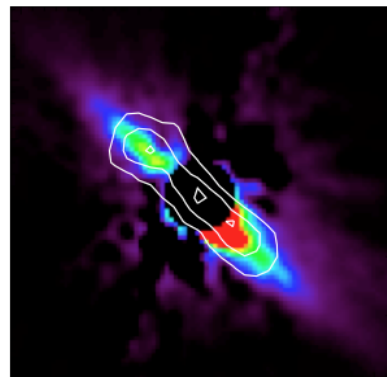
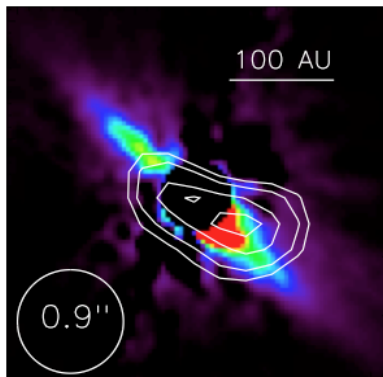


Debris Disks at Millimeter Wavelengths: First Mapping with CARMA



Holly Maness (UC Berkeley)

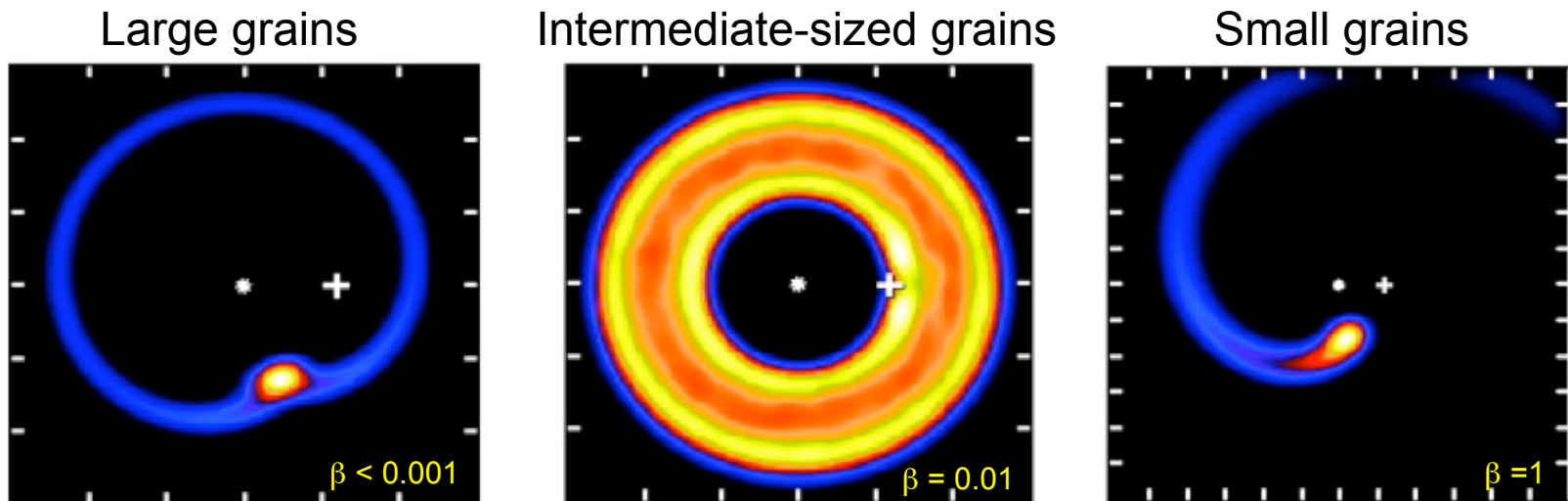
Collaborators: Mike Fitzgerald, Roberta Paladini, Paul Kalas, Gaspard Duchene,
Jonathan Williams, James Graham

Special thanks: Stuartt Corder, John Carpenter, CARMA Integration Team

Why millimeter interferometry?

- Different wavelengths probe different dust (e.g., millimeter traces **large** dust)
- To test models, need resolved observations spanning a wide range in wavelength

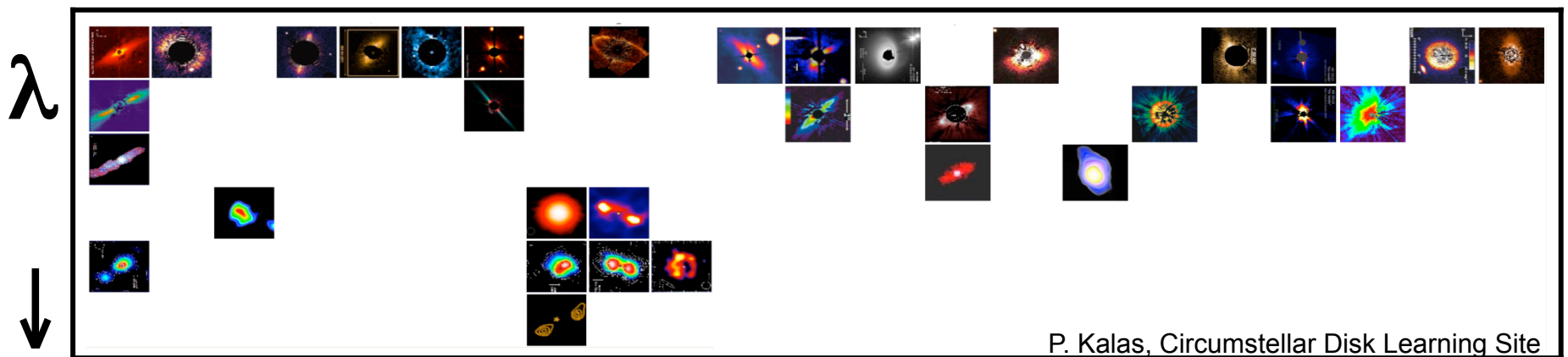
Resonant debris disk models, Wyatt (2006):



Why millimeter interferometry?

- Few disks with images spanning more than a decade in wavelength
- Therefore, observe small scattered-light disks at high resolution with millimeter interferometers

Resolved sources →



Why CARMA?

- Unprecedented image fidelity: more antennas than any other (sub)mm array to date
- Improved site relative to precursor OVRO and BIMA arrays
- Comparable sensitivity to past / current facilities
(currently 1 mJy beam⁻¹ in 8-hr track, will improve to 0.6 mJy beam⁻¹ this spring)
- The bad news: must target brightest sources with current generation arrays

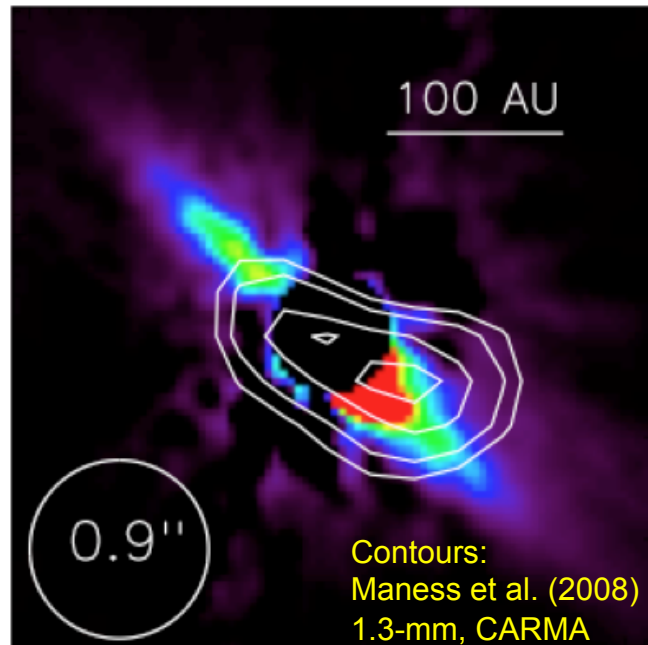
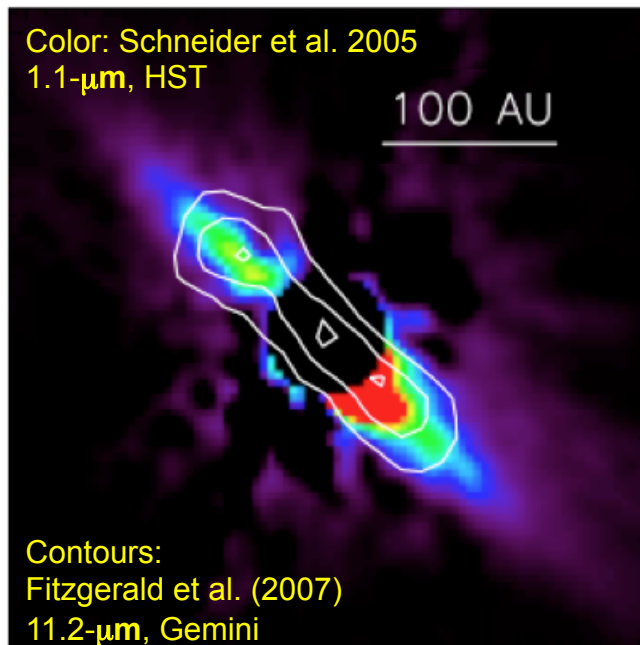


Photo Credit: <http://www.mmarray.org/>

Results: HD 32297

(Maness et al. 2008)

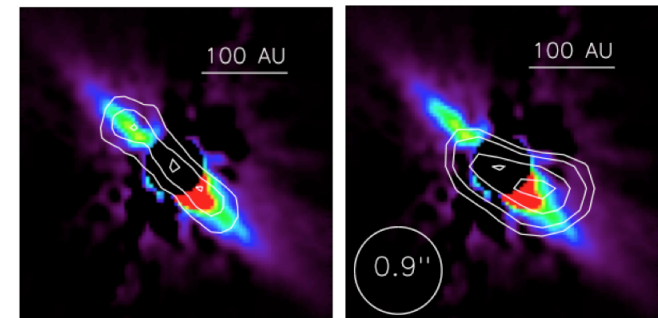
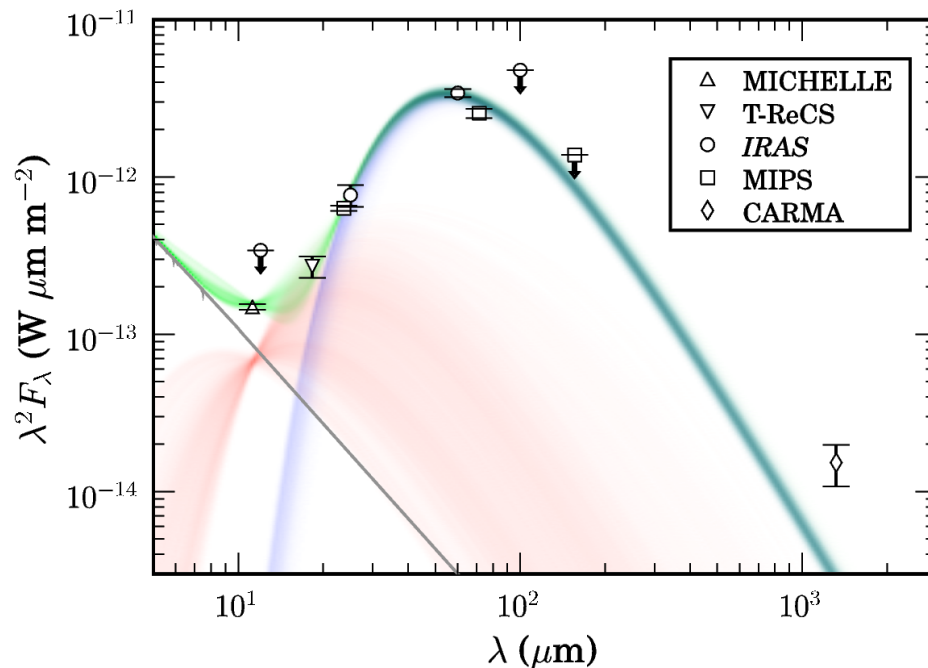
- A5V star, 30 Myr, 112 pc
- Brightness asymmetry in scattered-light, NOT observed in the mid-infrared
- CARMA map also shows an asymmetry



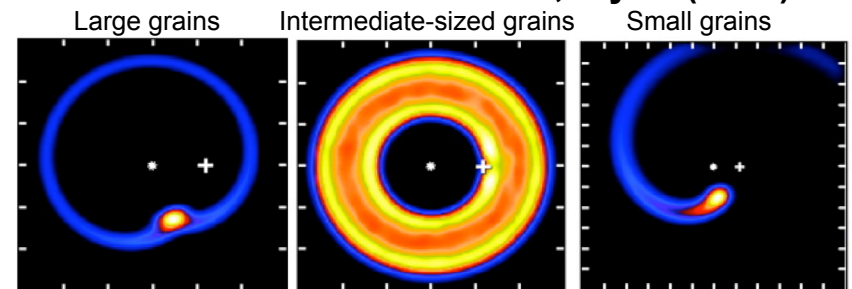
Results: HD 32297

(Maness et al. 2008)

- SED modeling corroborates evidence in images for separate grain populations
- Future dynamical modeling can test origin of observational results



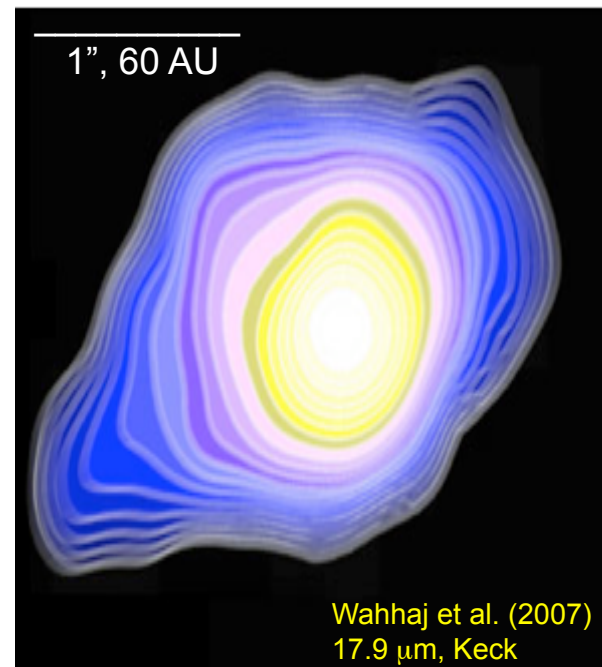
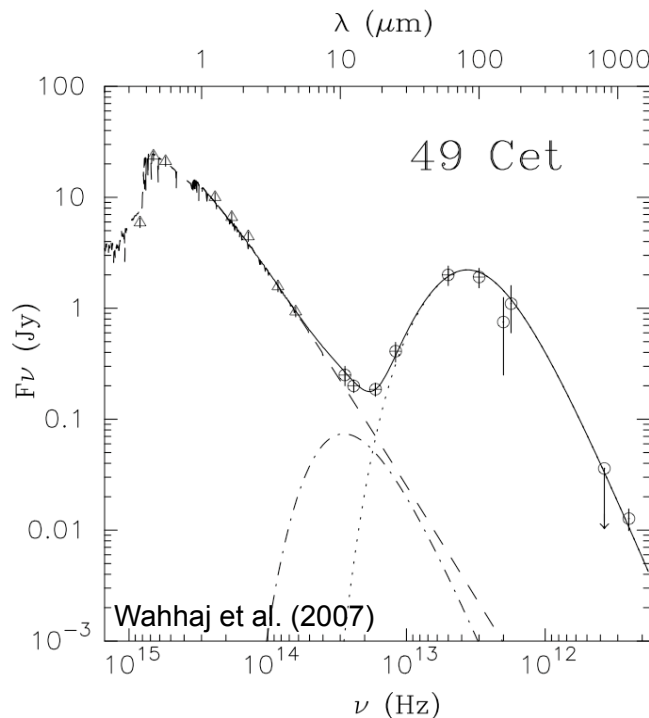
Resonant debris disk models, Wyatt (2006):



Results: 49 Ceti

(Maness et al., in prep)

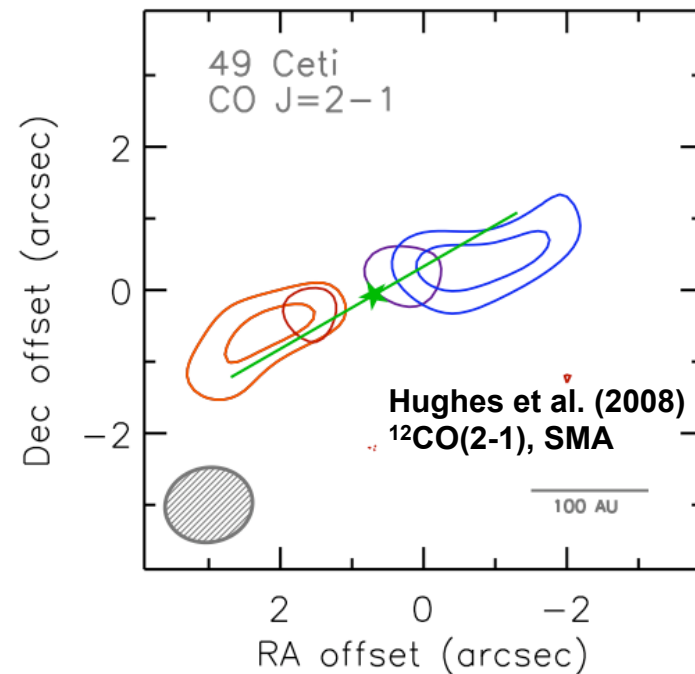
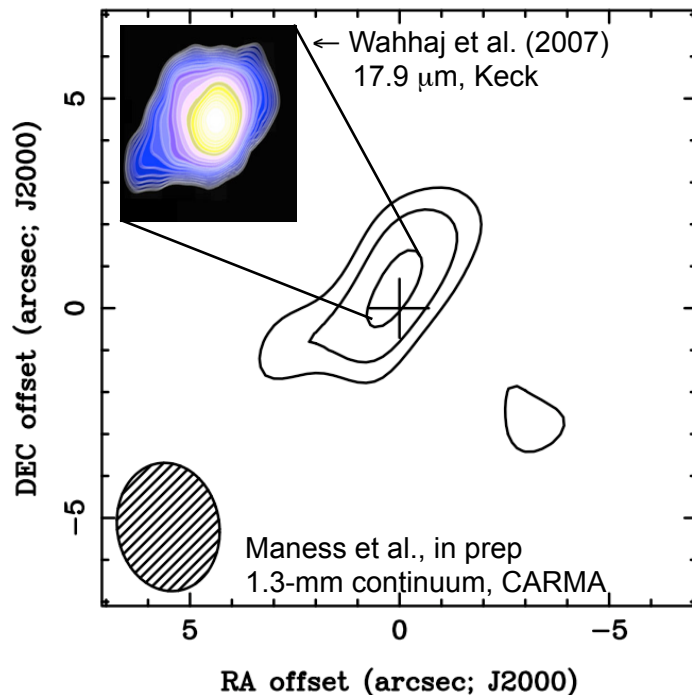
- A1V star, 8 Myr, 61 pc
- Dust imaged in mid-infrared contributes negligibly to observed excess
- Additional extended disk of large grains needed to explain SED



Results: 49 Ceti

(Maness et al., in prep)

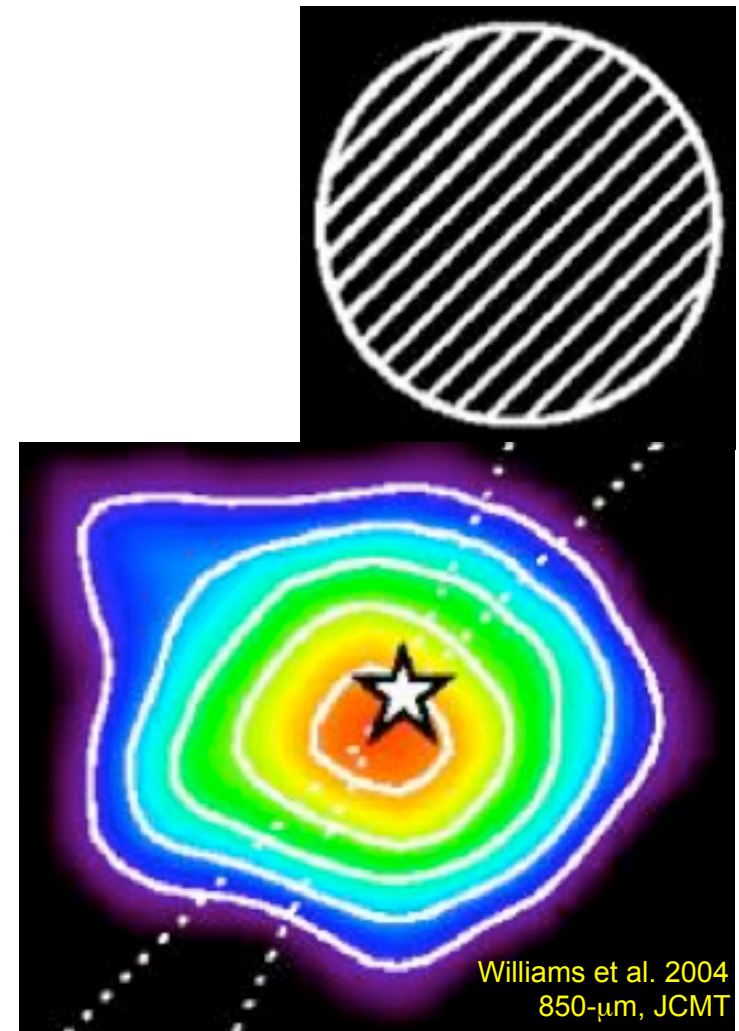
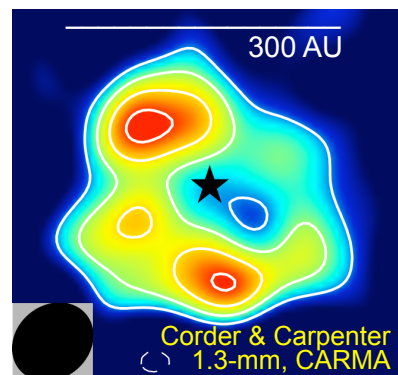
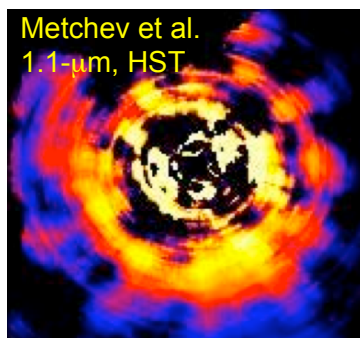
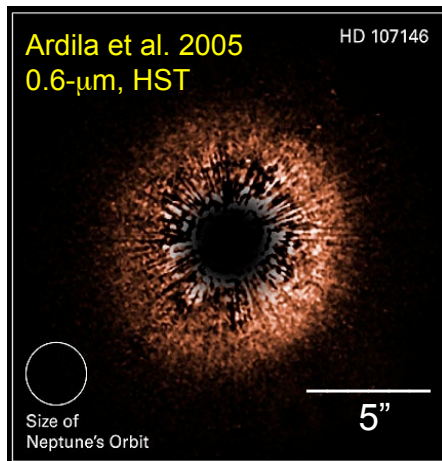
- CARMA map reveals large grain population previously only hypothesized from the SED
- New map allows detailed study of disk structure and chemistry at this late transitional stage



Results: HD 107146

(Corder & Carpenter)

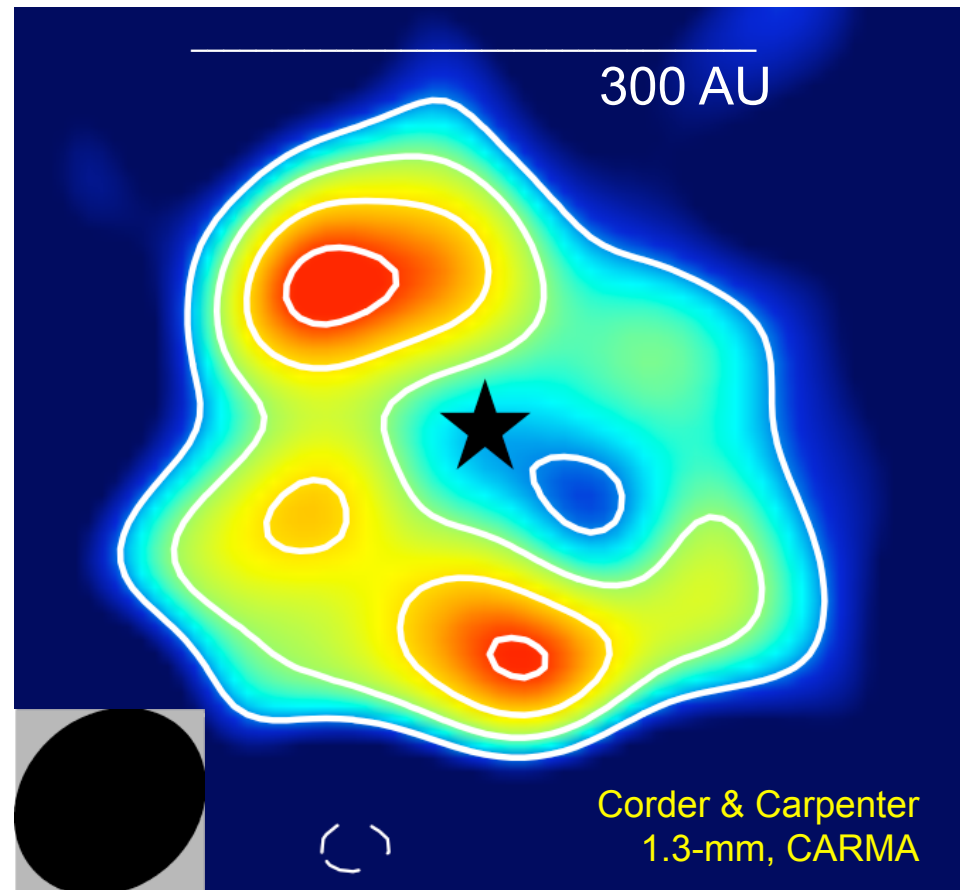
- G2V star, 30-100 Myr, 30 pc



Results: HD 107146

(Corder & Carpenter)

- Depression in dust distribution inwards of approximately 50 AU
- Ring substructure possibly points to a planetary-induced resonance



Future Prospects

- Sensitivity limitations will continue to make this field challenging, but...
 - Roughly 5 more resolved debris disks are accessible to (sub)mm interferometers TODAY.
 - Another ~5 will be accessible within the next year, following instrument upgrades.
 - Upcoming surveys (e.g., Herschel, SCUBA-2) will identify somewhere between a few to tens of new targets suitable for high resolution follow-up.

Summary

- CARMA is helping to expand the number of debris disks with resolved observations spanning several decades in wavelength; these multi-wavelength data sets provide crucial information for dynamical modeling.

