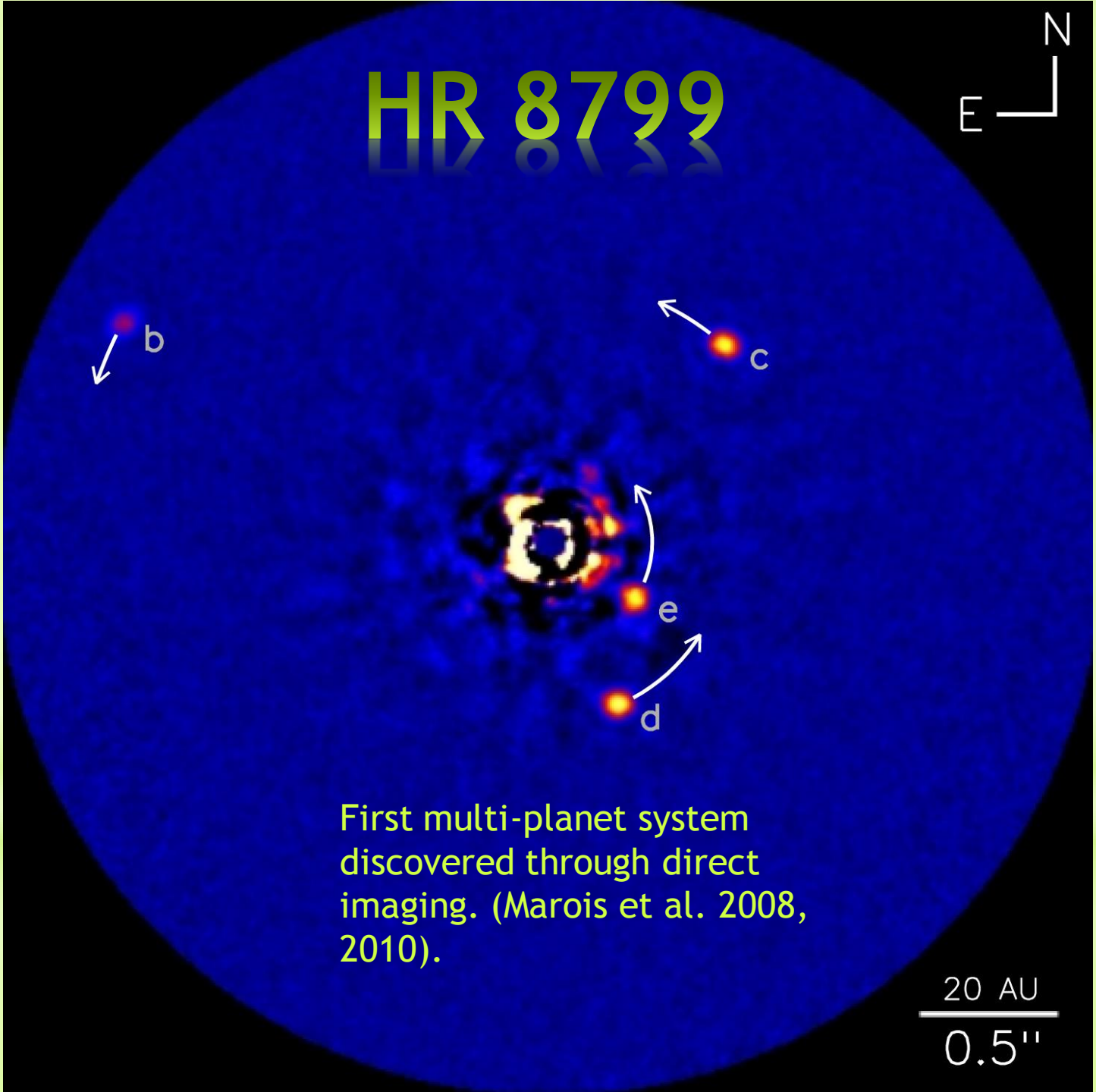
# HR 8799: Giant Planets, Giant Debris Disc

Mark Booth
FONDECYT Fellow
Pontificia Universidad Católica de Chile

# HR 8799

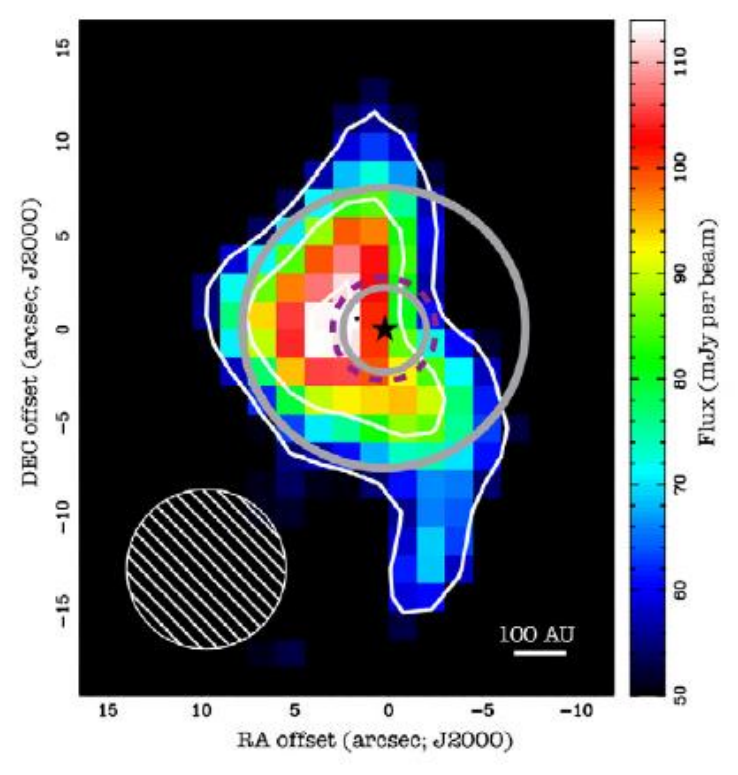



First multi-planet system discovered through direct imaging. (Marois et al. 2008, 2010).

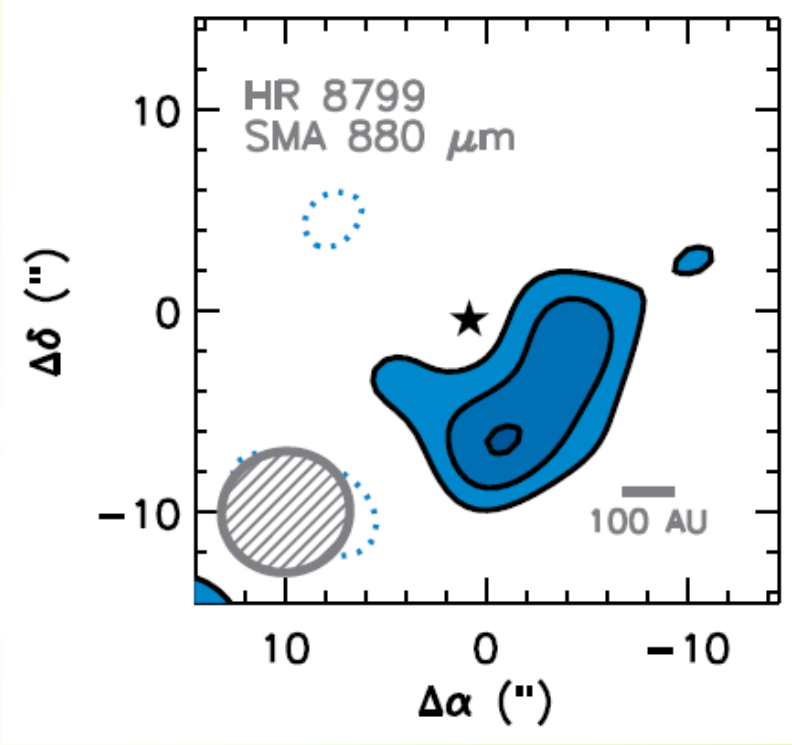
# HR 8799's Debris Disc

- Discovered by IRAS. (Sadakane & Nishida 1986)
- Resolved at 24 μm with Spitzer. (Su et al. 2009)
- Warm component also detected.

# Clumps?

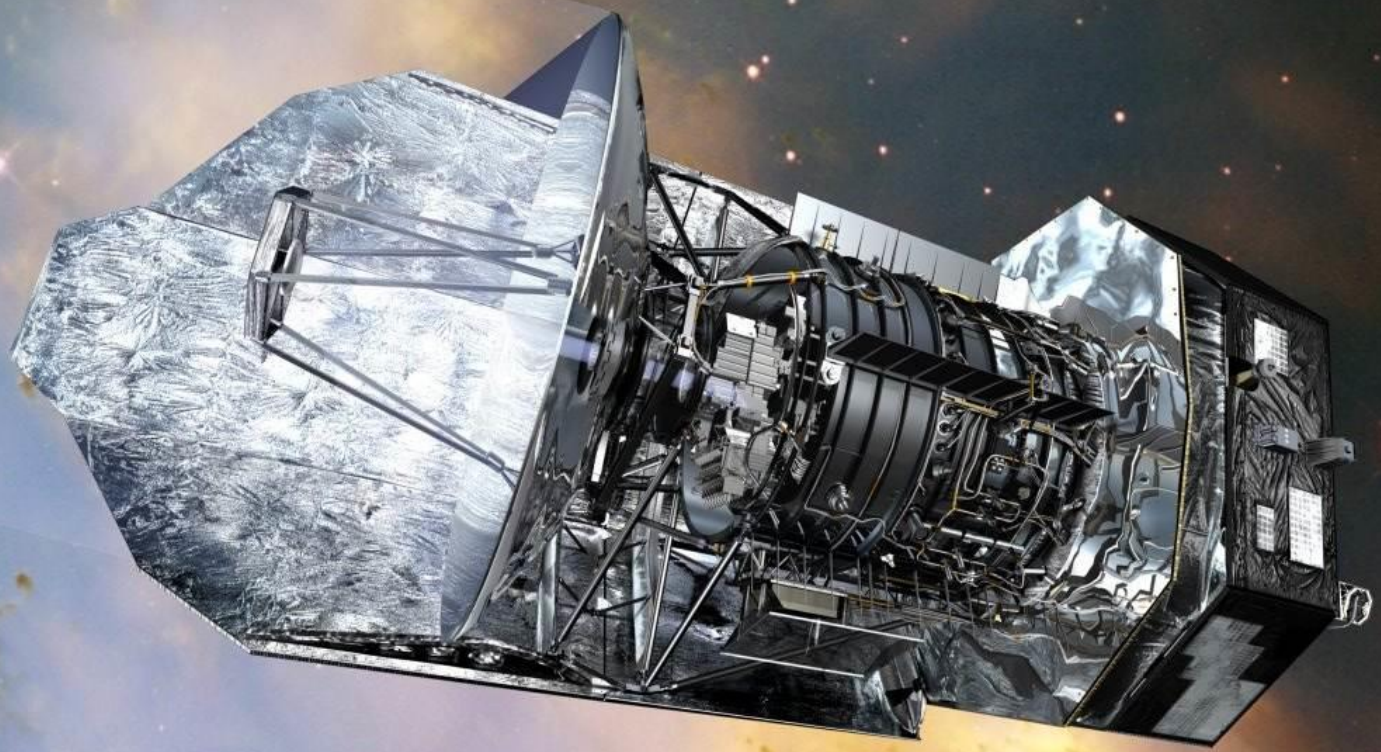



CSO (350 μm)
Patience et al. (2011)



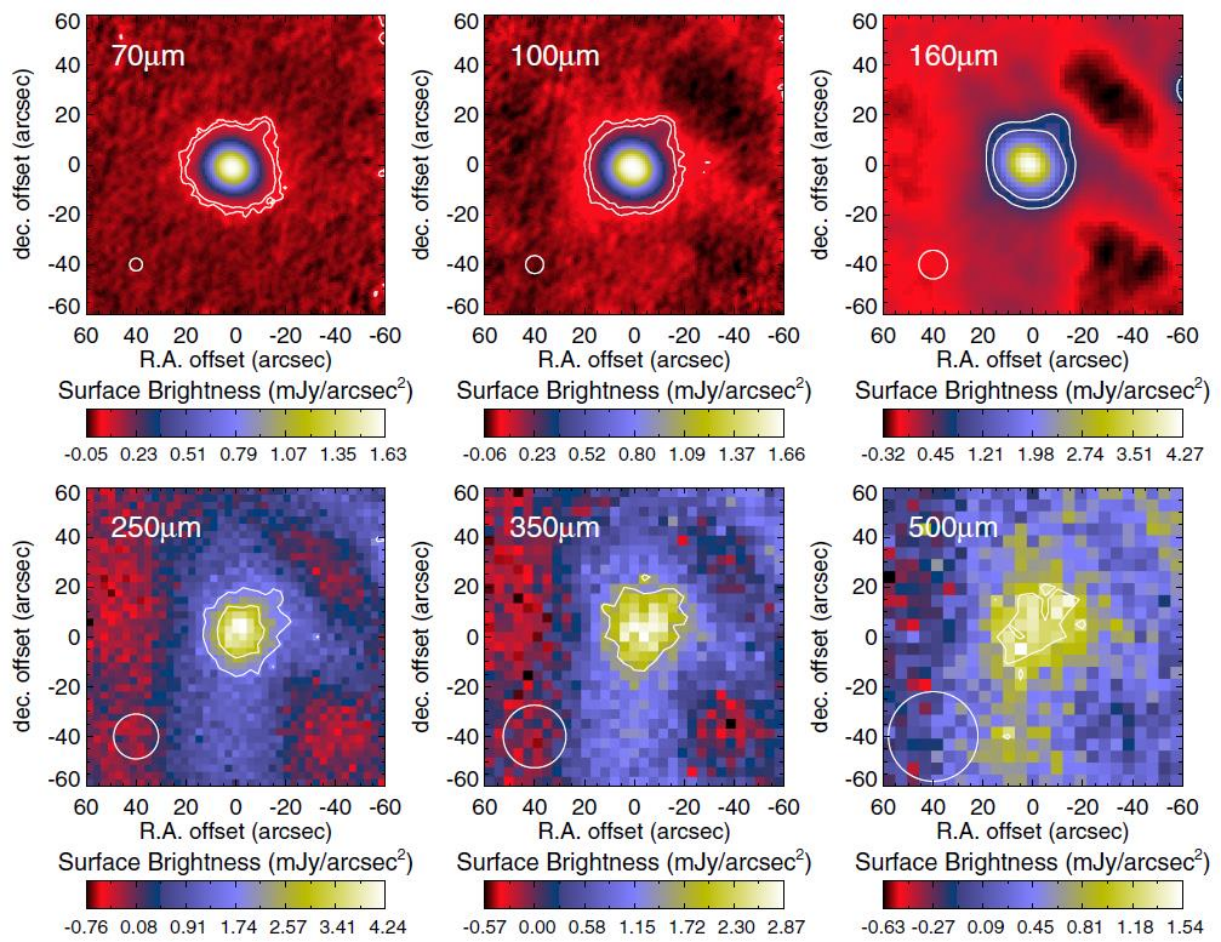

SMA (880 μm)
Hughes et al. (2011)

# Herschel

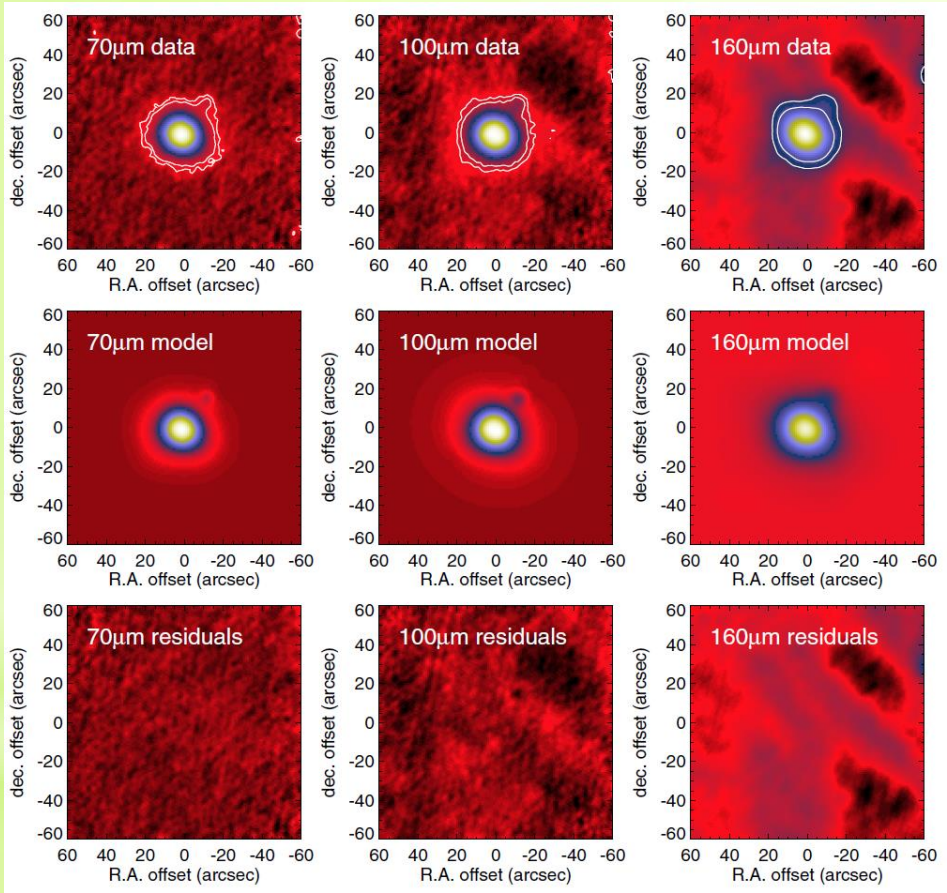


*Matthews, B., Kennedy, G., Sibthorpe, B., Booth, M., Wyatt, M., Broekhoven-Fiene, H., Macintosh, B. and Marois, C. 2014, ApJ, 780, 97*

# Herschel

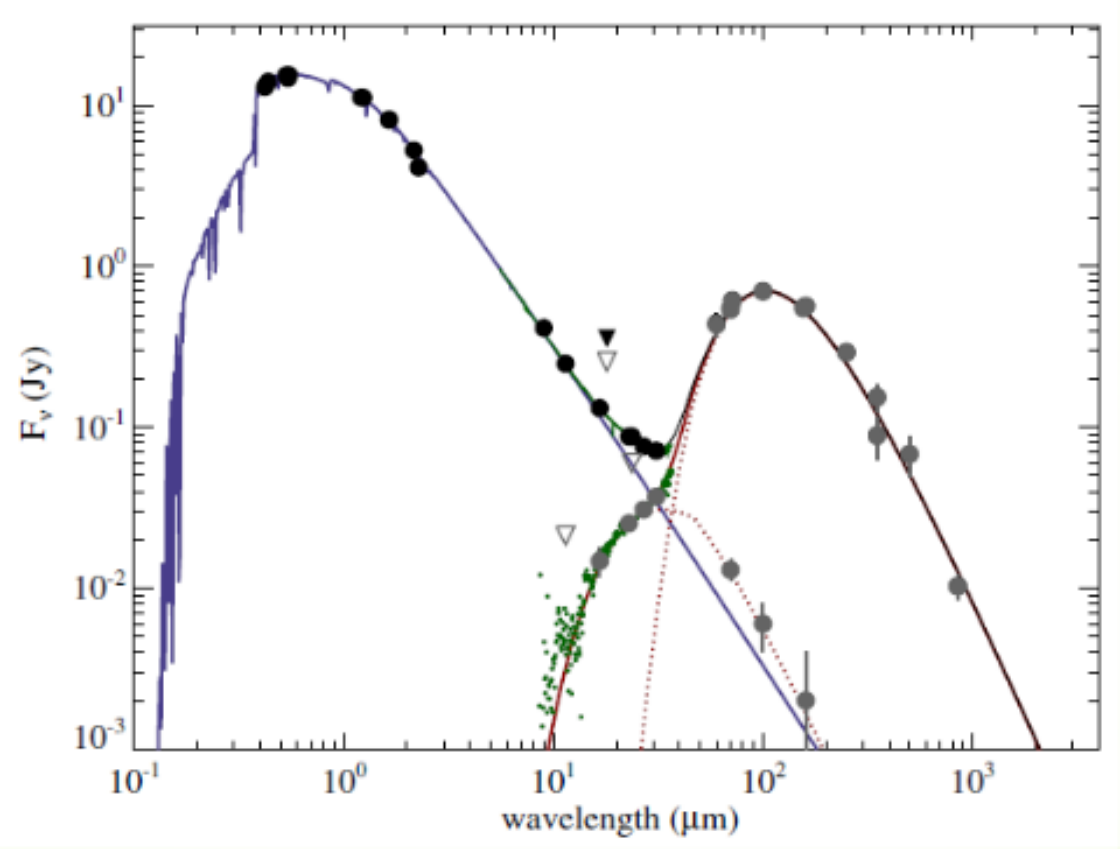

70μm
100μm
160μm
250μm
350μm
500μm
dec. offset (arcsec)
R.A. offset (arcsec)
60 40 20 0 -20 -40 -60
Surface Brightness (mJy/arcsec²)
-0.05 0.23 0.51 0.79 1.07 1.35 1.63
-0.06 0.23 0.52 0.80 1.09 1.37 1.66
-0.32 0.45 1.21 1.98 2.74 3.51 4.27
-0.76 0.08 0.91 1.74 2.57 3.41 4.24
-0.57 0.00 0.58 1.15 1.72 2.30 2.87
-0.63 -0.27 0.09 0.45 0.81 1.18 1.54

# Image Modelling

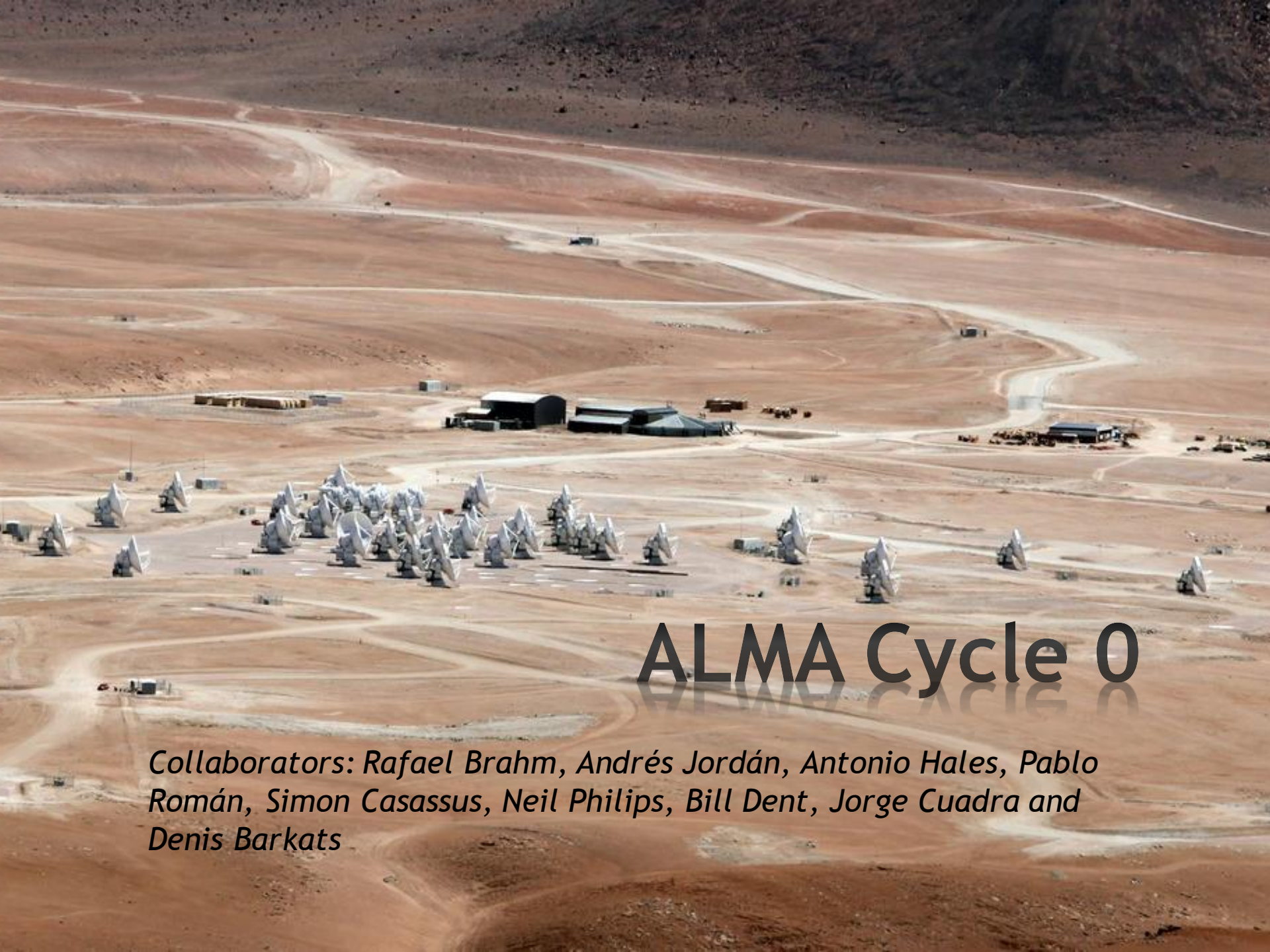



- The images are best fit by a disc with an inclination of 26°.
- The disc is formed of an inner warm component, a planetesimal belt between 100 and 310 AU and a blowout halo extending out to 2000 AU.

# Spectral Energy Distribution



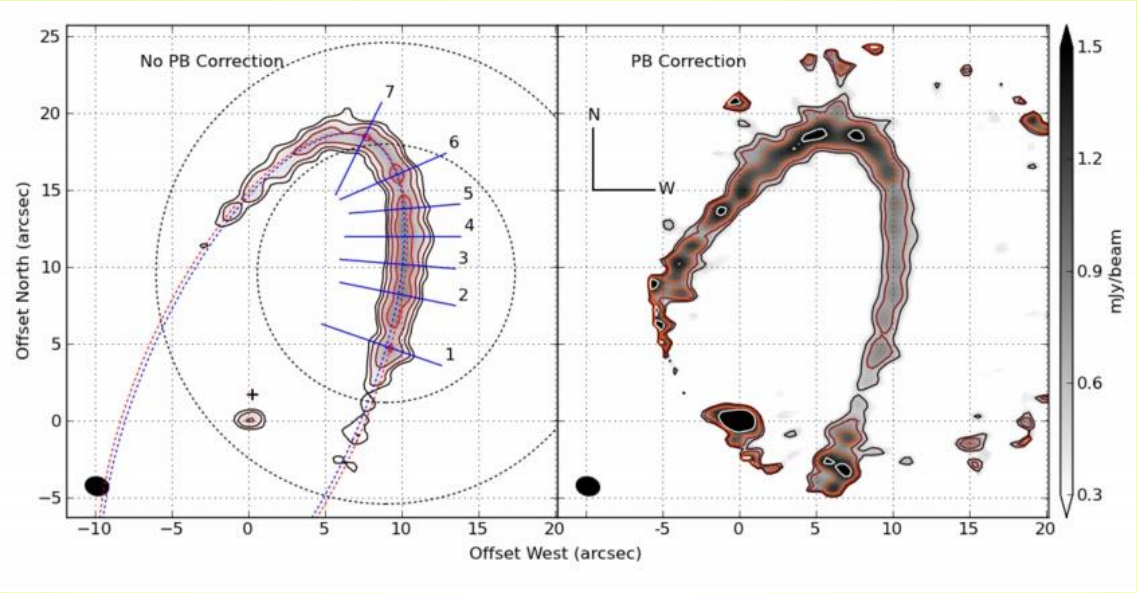

- The SED is well fit by a two temperature disc.



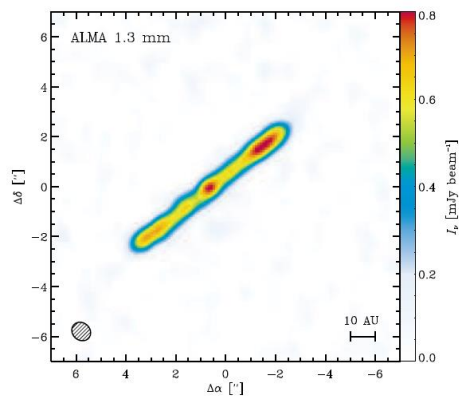
# ALMA Cycle 0

*Collaborators: Rafael Brahm, Andrés Jordán, Antonio Hales, Pablo Román, Simon Casassus, Neil Philips, Bill Dent, Jorge Cuadra and Denis Barkats*

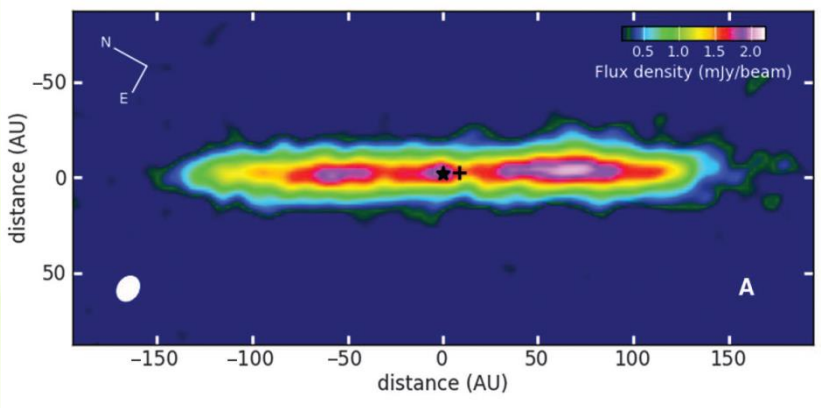
Fomalhaut
Boley et
al. 2010




# ALMA Debris Disc Observations

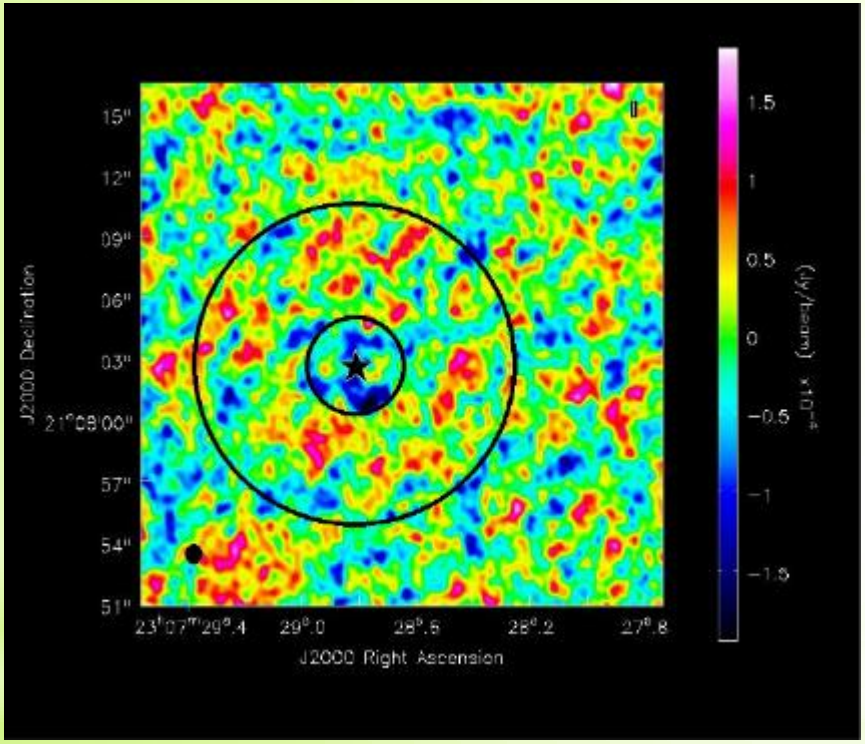



AU Mic
Macgregor et al. 2013




Beta Pic
Dent et al. 2014

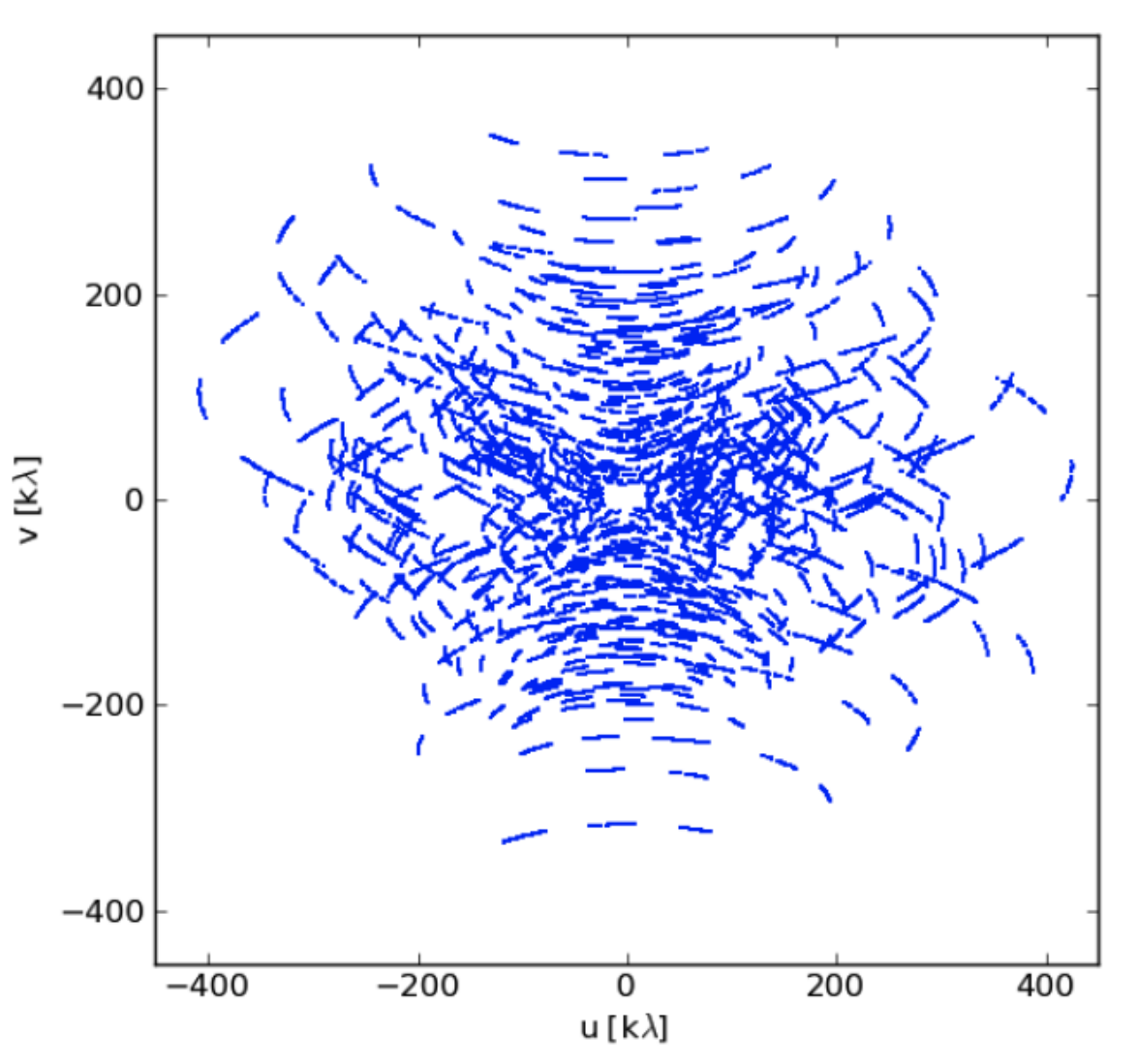
# ALMA Cycle 0




- Observed with Band 7 (870 μm)
- Total time 4.7 hours
- Between 13 and 27 antennas

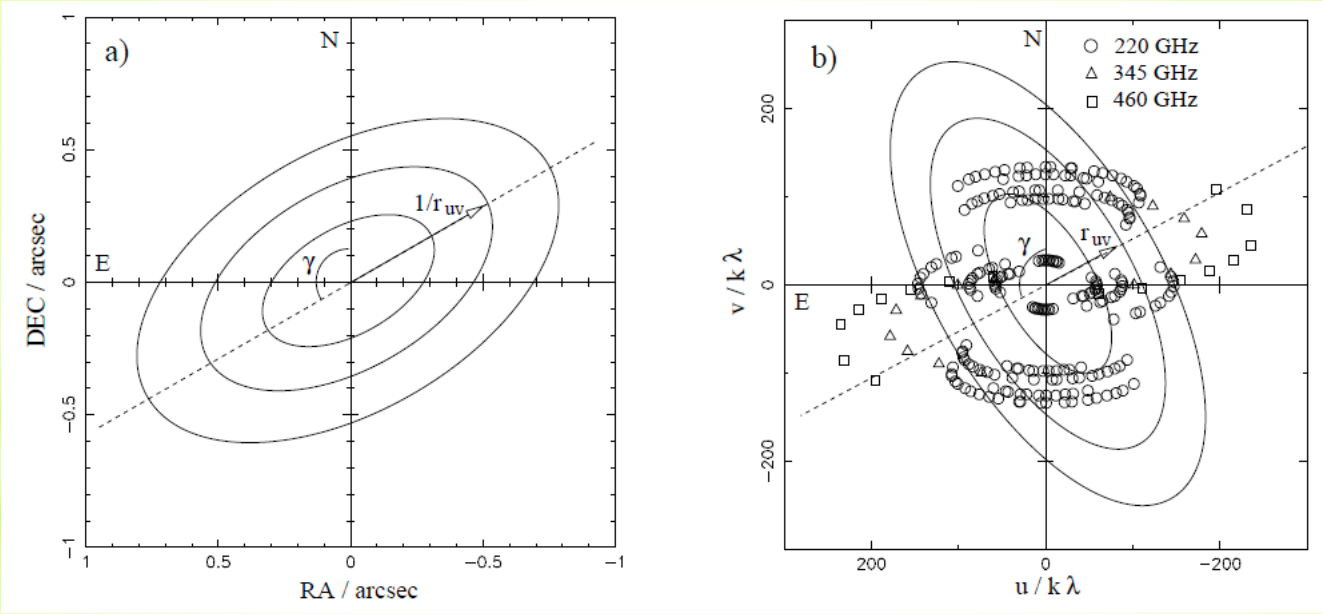
- NO DETECTION

# Visibilities



# Visibilities

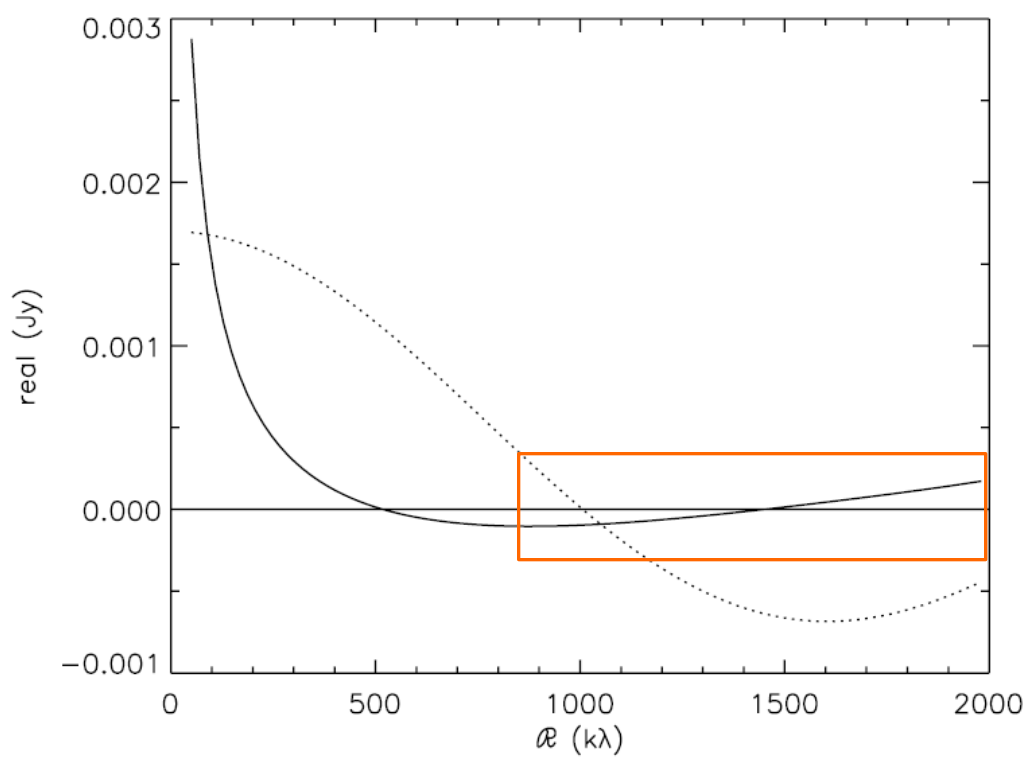
The fourier transform of an ellipse is also an ellipse but at right angles to the original. We can use this to deproject and azimuthally average the visibilities.




Lay, Carlstrom and Hills 1997

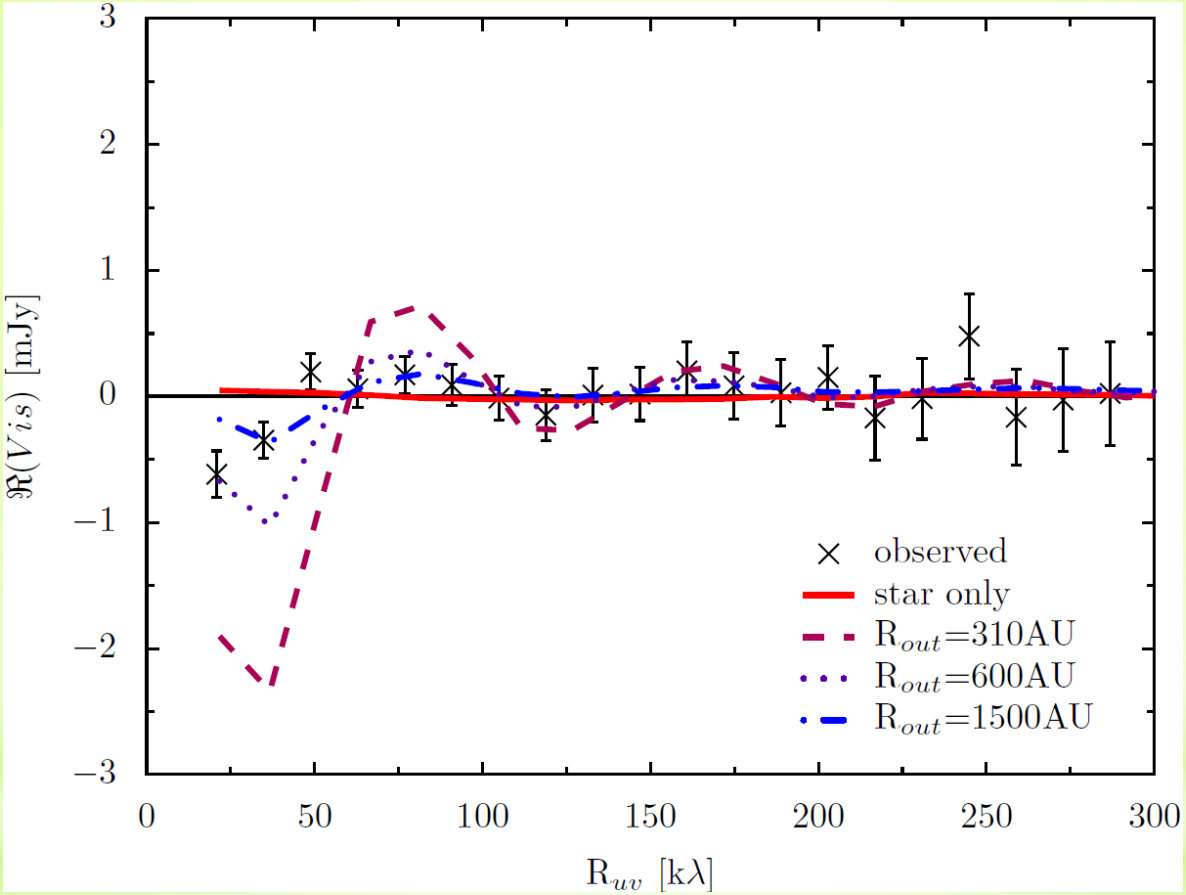
# Visibilities

Solid line: wide disc with inner hole.
Dotted line: thin ring




Hughes et al. 2007

# Real Visibilities

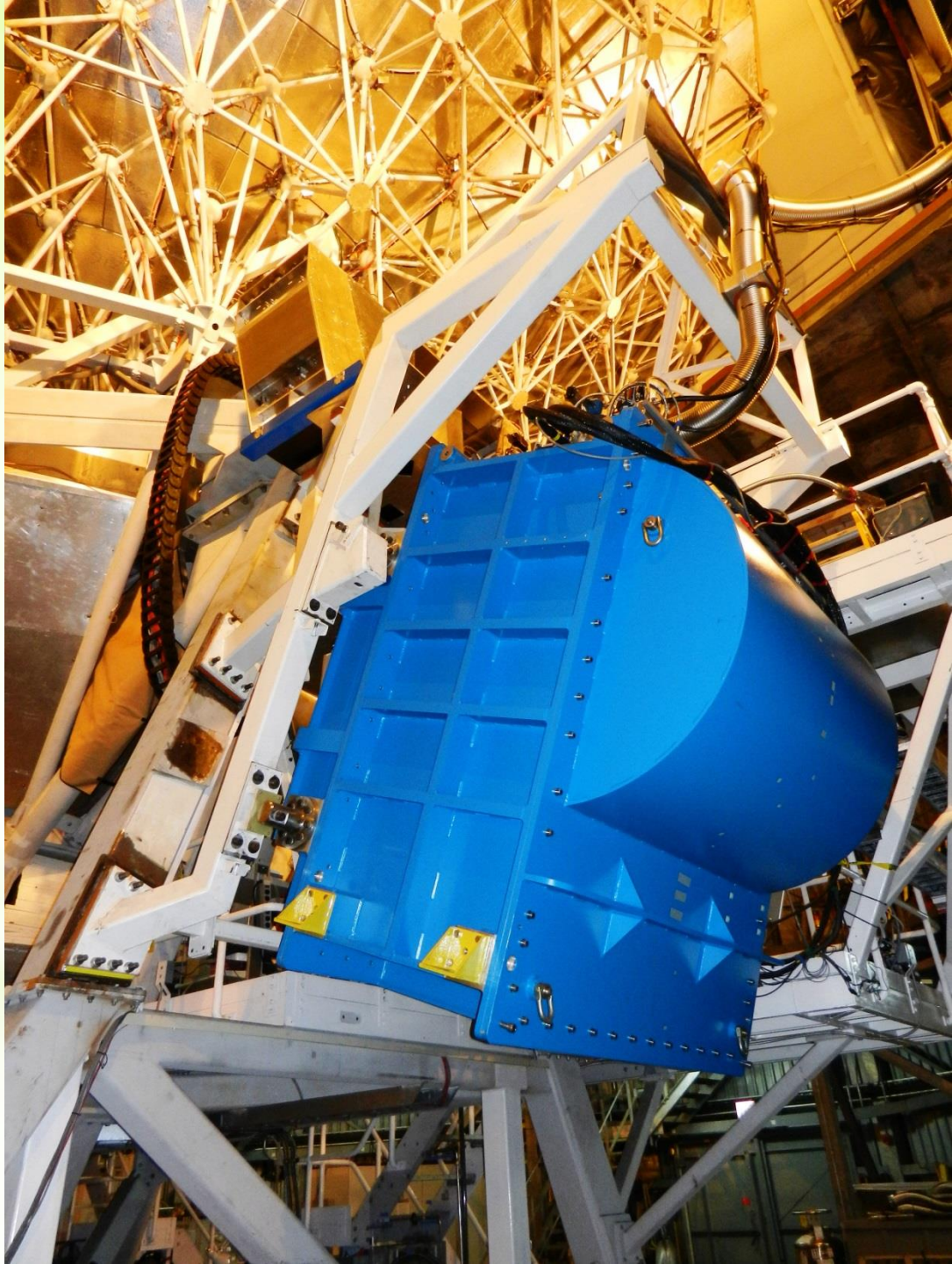



From this we can constrain the width of the disc and the inner edge.

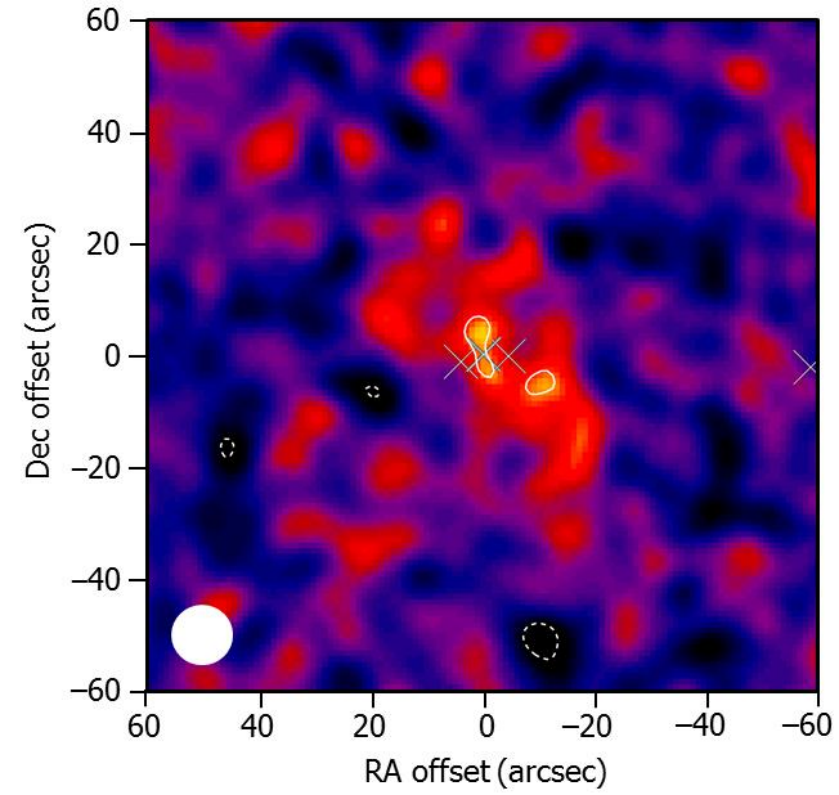
# SONS JLS

*Collaborators: Wayne Holland, Brenda Matthews and the SONS JLS Team*

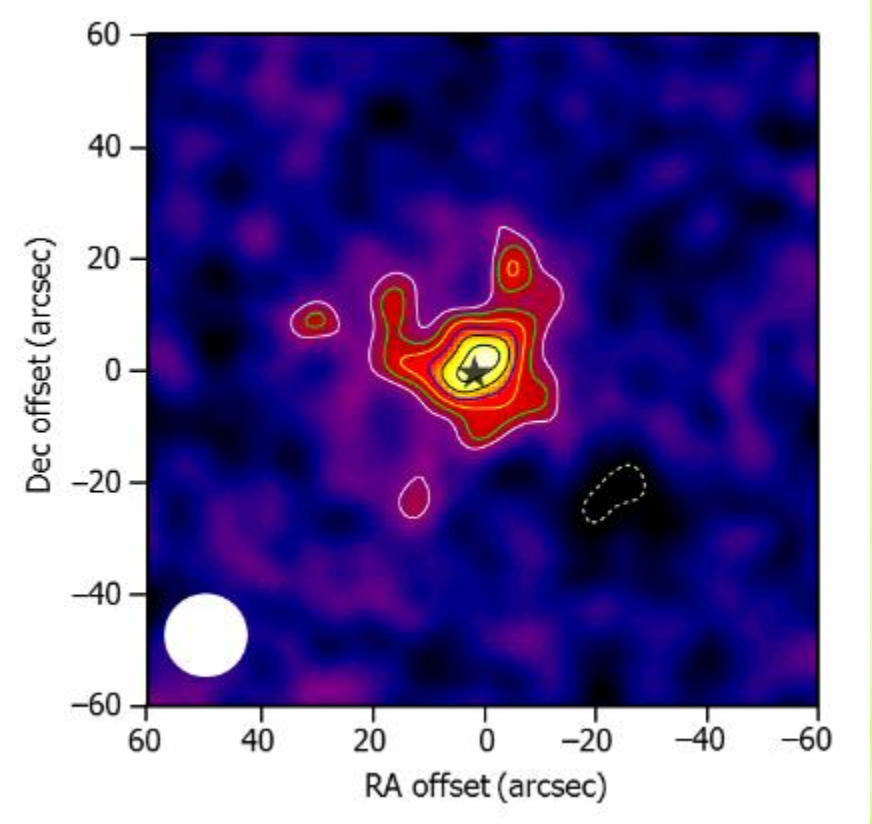
SONS is one of 7 Legacy Surveys currently underway on the James Clerk Maxwell telescope (JCMT), searching for debris signatures in the form of excess emission at 850 μm around 115 nearby stars.



# SONS JLS




450 μm




850 μm

# SONS JLS

- Peak flux is 9.5 ± 1.2 mJy/beam
- Compares well with that from SCUBA: 10.3 ± 1.8 mJy/beam
- SCUBA-2 clearly shows resolved emission, unlike SCUBA
- Total flux is 28.7 ± 3.0 mJy in a 60” aperture.
- Preliminary Gaussian fitting gives a disc radius of 600 AU.

# Conclusions

- The spectral energy distribution is well fit by two narrow rings but the resolved emission shows dust out to ~2000 AU.
- The Herschel data can be explained by the Su et al. (2009) model with a planetesimal belt between 100 and 310 AU and a halo of blowout grains beyond this.
- The ALMA cycle 0 data shows that the planetesimal belt must be wider than this and confirms the smooth nature of the disc.
- The SONS data also shows the disc to be wider with an outer edge of ~600 AU.