The Vega Debris Disc

A view from Herschel

Bruce Sibthorpe on behalf of the PACS/SPIRE GT debris disc team
UK ATC

The Programme and the Team

- Collaboration between the SPIRE and PACS guaranteed time teams
- Photometric and spectroscopic observations of 6 famous debris discs
  - Vega, β Pic, ε Eri, Fomalhaut, AU Mic, τ Ceti
- See A&A Herschel special edition papers Sibthorpe et al. 2010 and Vandenbussche et al. 2010 for results from Vega and beta Pic observations

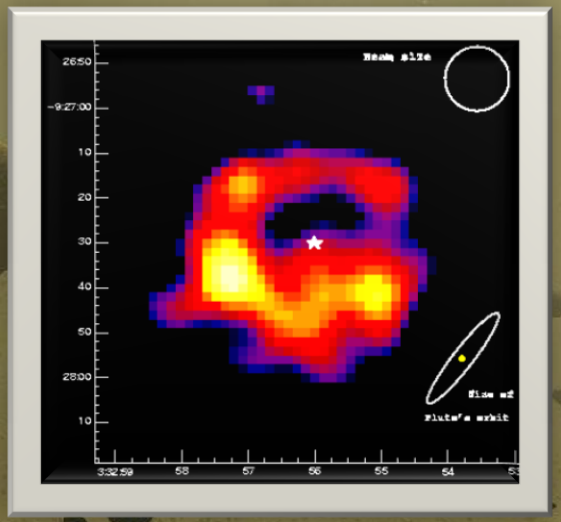
The Team

B. Sibthorpe, B. Vandenbussche, J. S. Greaves, E. Pantin, G. Olofsson, B. Acke, M. J. Barlow, J. A. D. L. Blommaert, J. Bouwman, A. Brandeker, M. Cohen, W. DeMeester, W. R. F. Dent, J. Di Francesco, C. Dominik, M. Fridlund, W. K. Gear, A. M. Glauser, H. L. Gomez, P. C. Hargrave, P. M. Harvey, Th. Henning, A. M. Heras, M. R. Hogerheijde, W. Holland, R. J. Ivison, S. J. Leeks, T. L. Lim, R. Liseau, B. C. Matthews, D. A. Naylor, G. L. Pilbratt, E. T. Polehampton, S. Regibo, P. Royer, A. Sicilia-Aguilar, B. M. Swinyard, C. Waelkens, H. J. Walker, R. Wesson

Debris Discs: An Overview

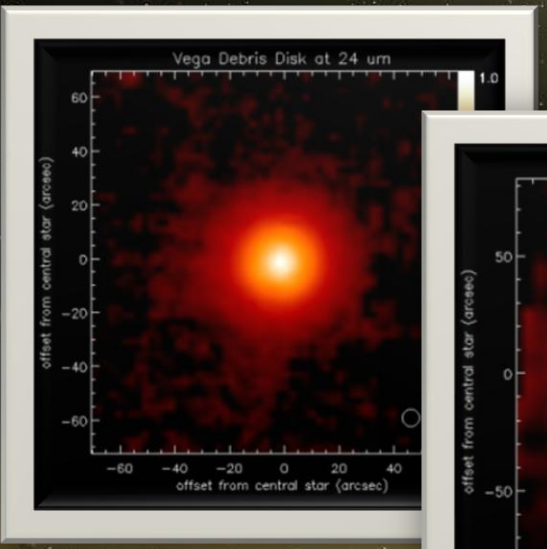
- Discs of second generation dust around main sequence stars
- Age greater than ~10 Myr
- Dust originates from a belt of planetesimals via a collisional cascade

Hubble/ACS – Kalas et al. 2008

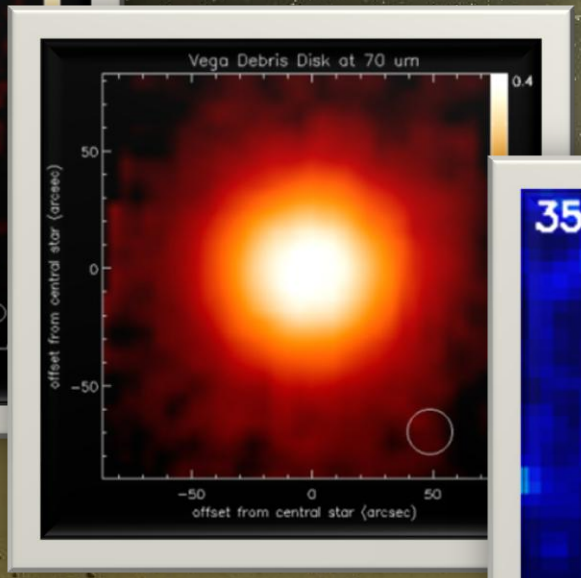


SCUBA – Greaves et al. 1998

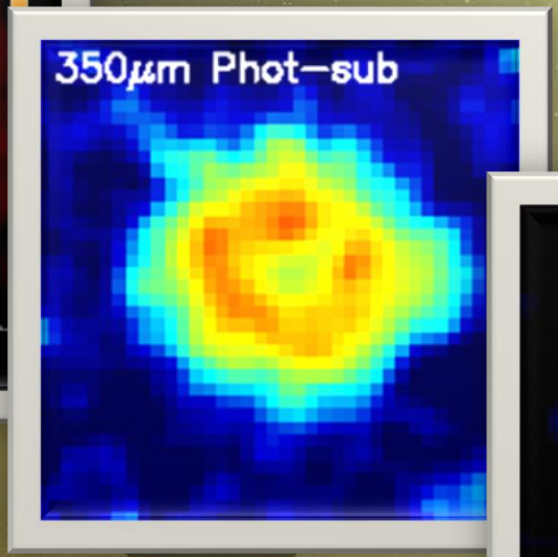
The Vega Debris Disc



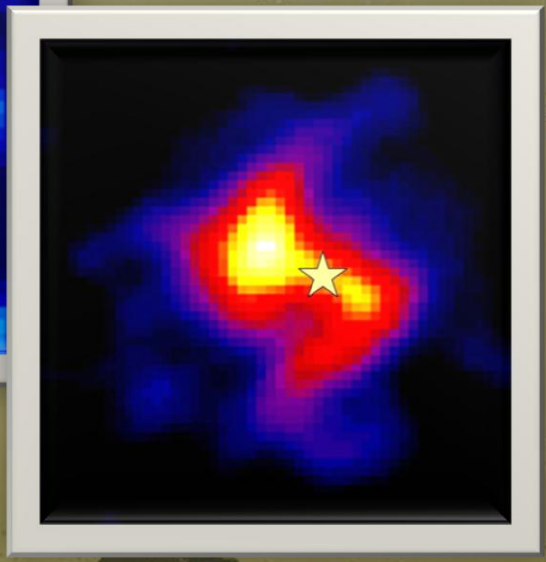
Spitzer 24 µm
Su et al 2005



Spitzer 70 µm
Su et al 2005

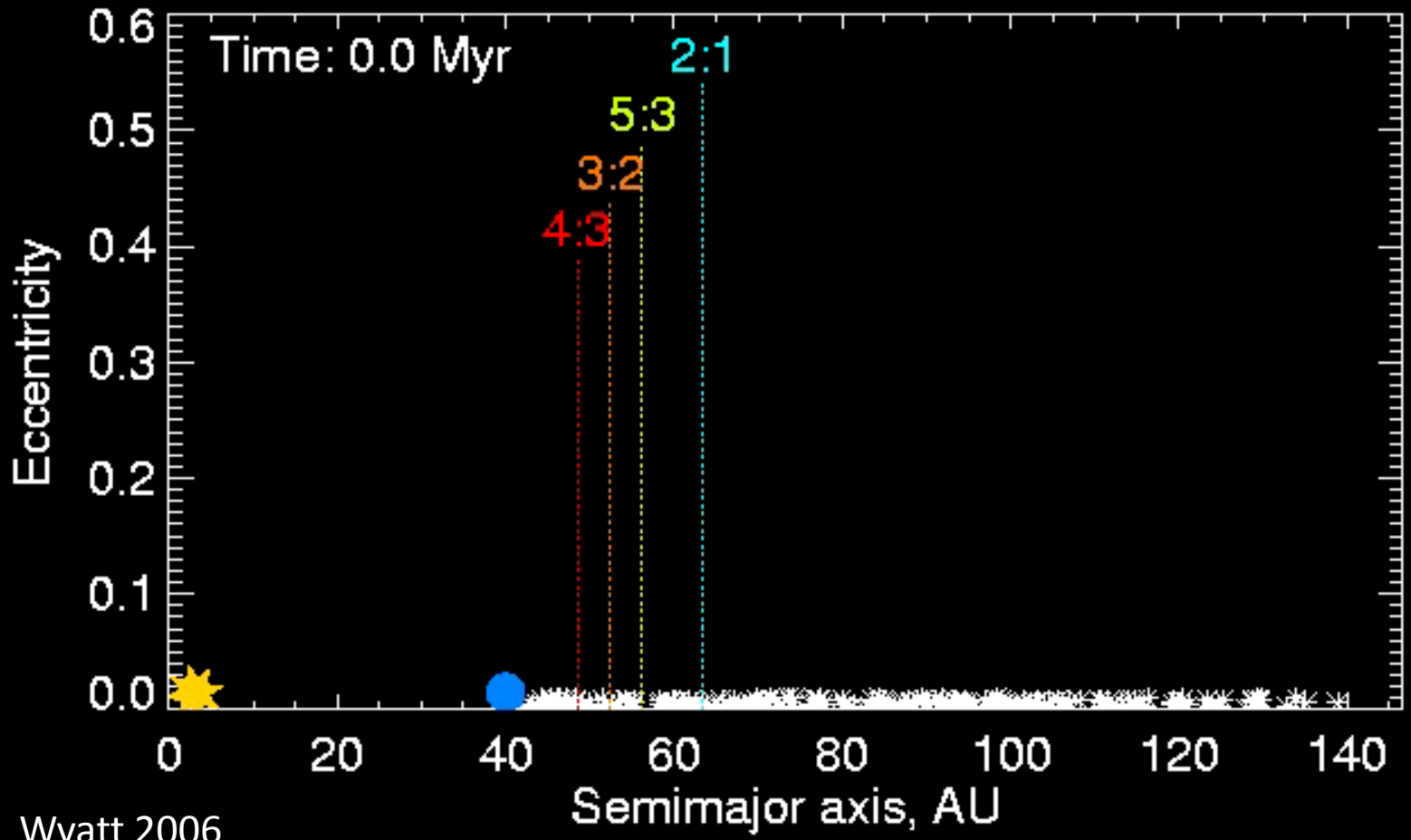


SHARC II 350 µm
Marsh et al 2005



SCUBA 850 µm
Holland et al 1998

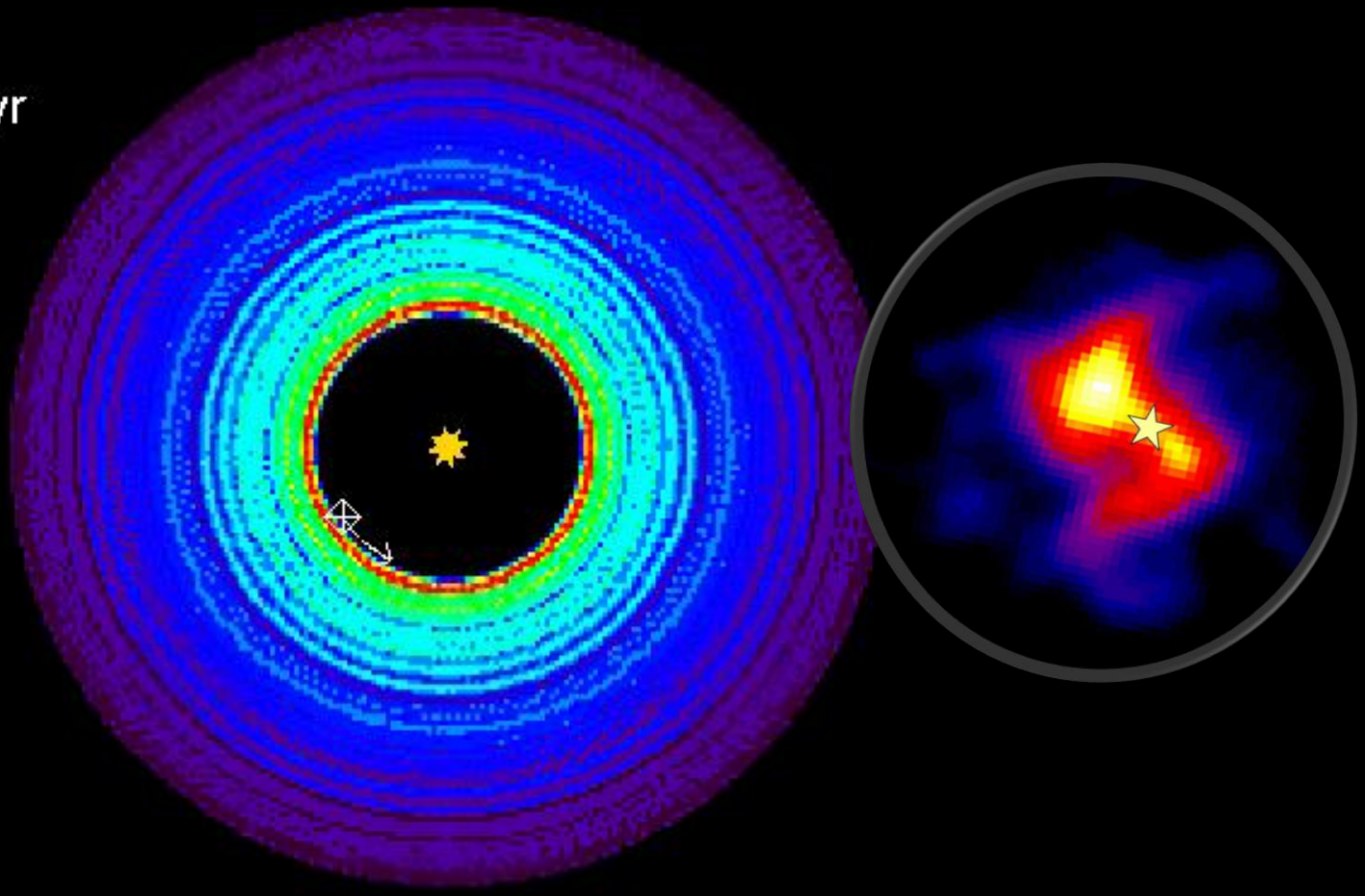
The outward migration of a Neptune mass planet (●) around Vega sweeps many comets (*) into the planet's resonances



Wyatt 2006

http://www.ast.cam.ac.uk/~wyatt/

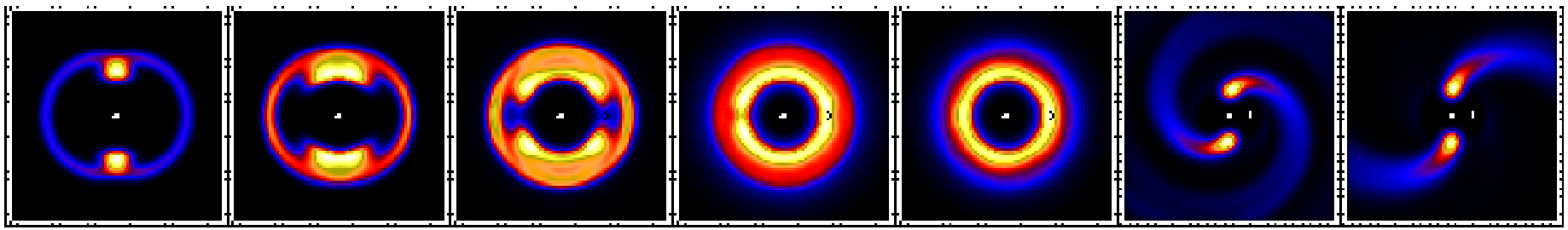
The trapping of comets in Vega's disk into planetary resonances causes them to be most densely concentrated in a few clumps



Wyatt 2006

http://www.ast.cam.ac.uk/~wyatt/

Modelled Images (Wyatt 2006)



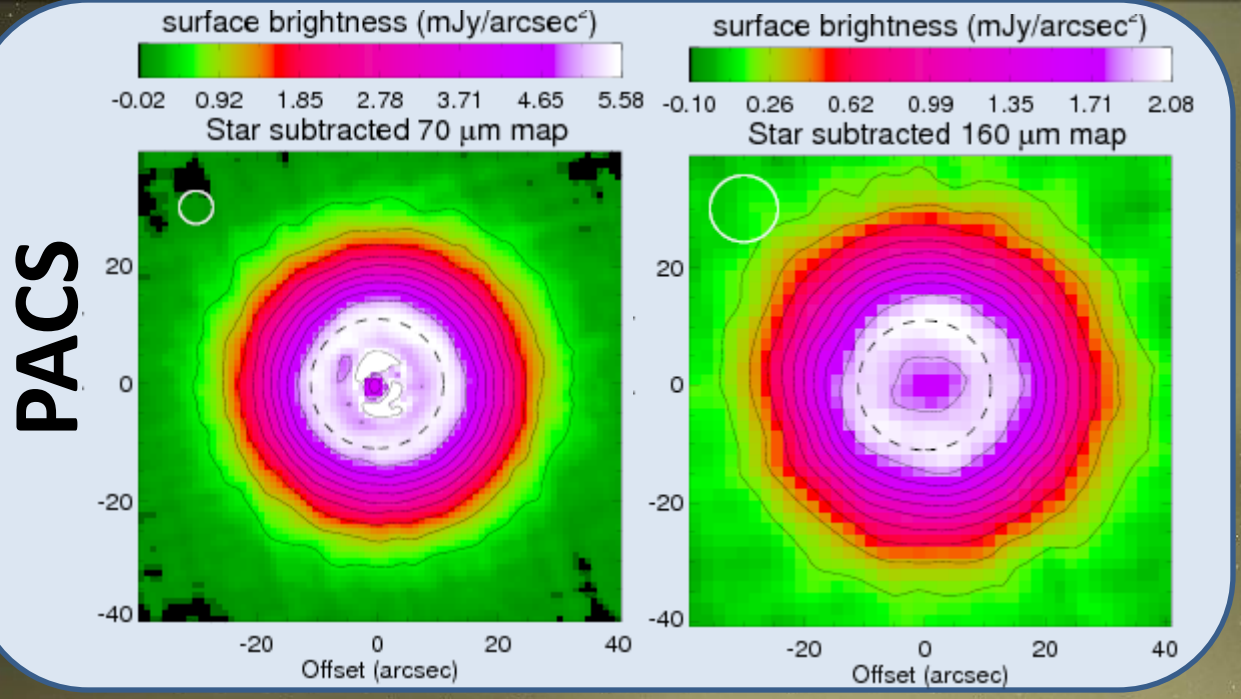
Long wavelength

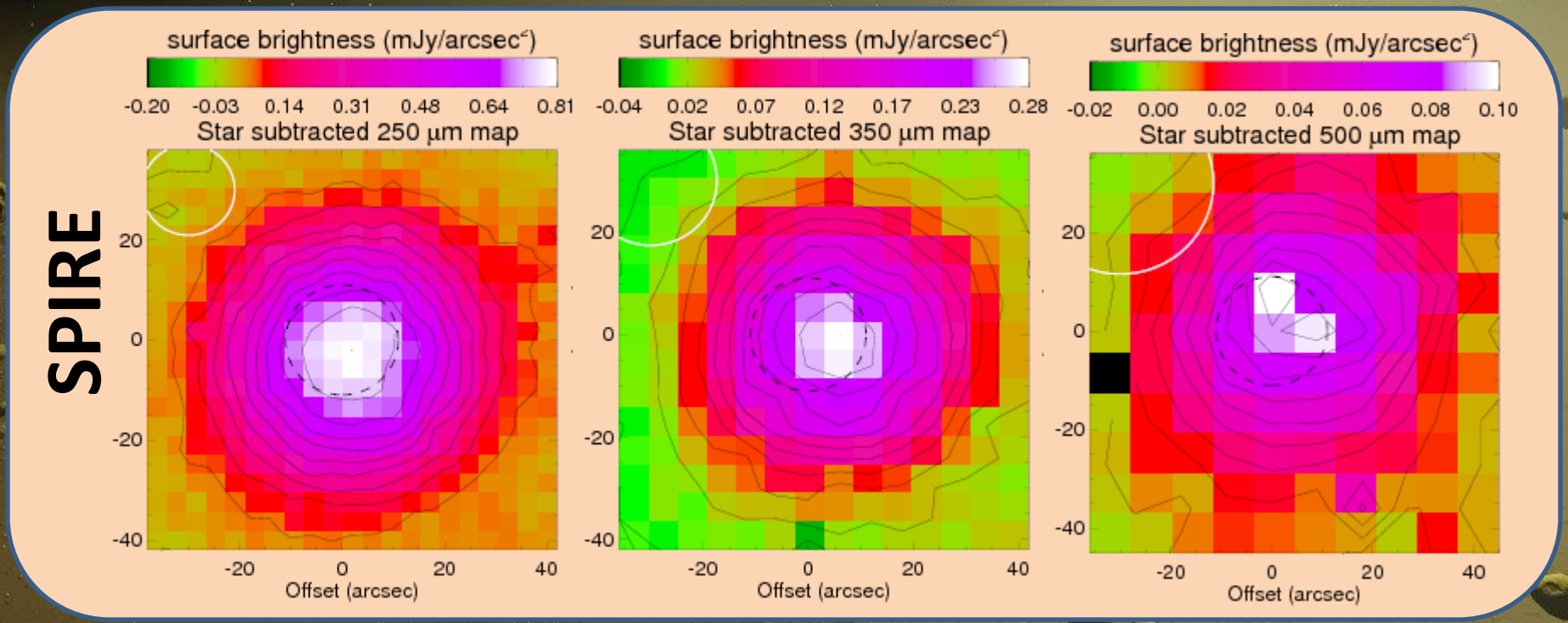
Short wavelength

See Wyatt 2006 for model details

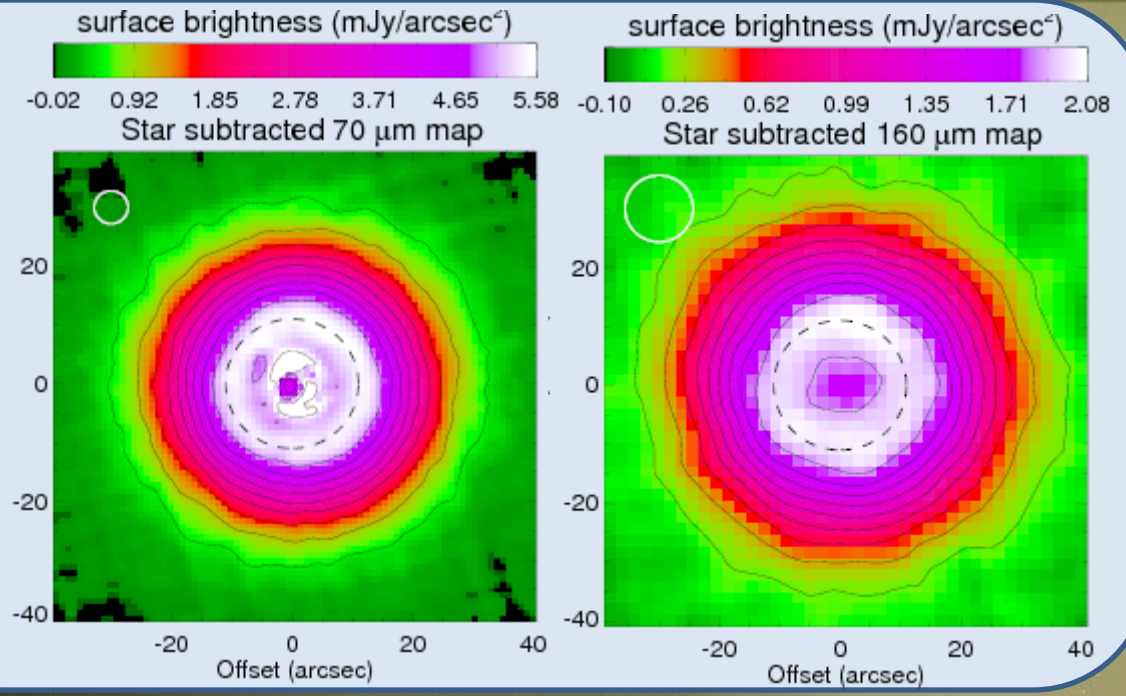
- Population I grains (> few mm)
  - Large dust grains in resonance with the planet
- Population II grains (few mm to a few μm)
  - Intermediate sized grains no-longer in resonance and in highly elliptical orbits
- Population III grains (< few μm)
  - Small grains blown out of the system upon creation
  - IIIa grains eminating from population I grains in resonant clumps
  - IIIb grains eminating from collisions of population II grains

Herschel Data

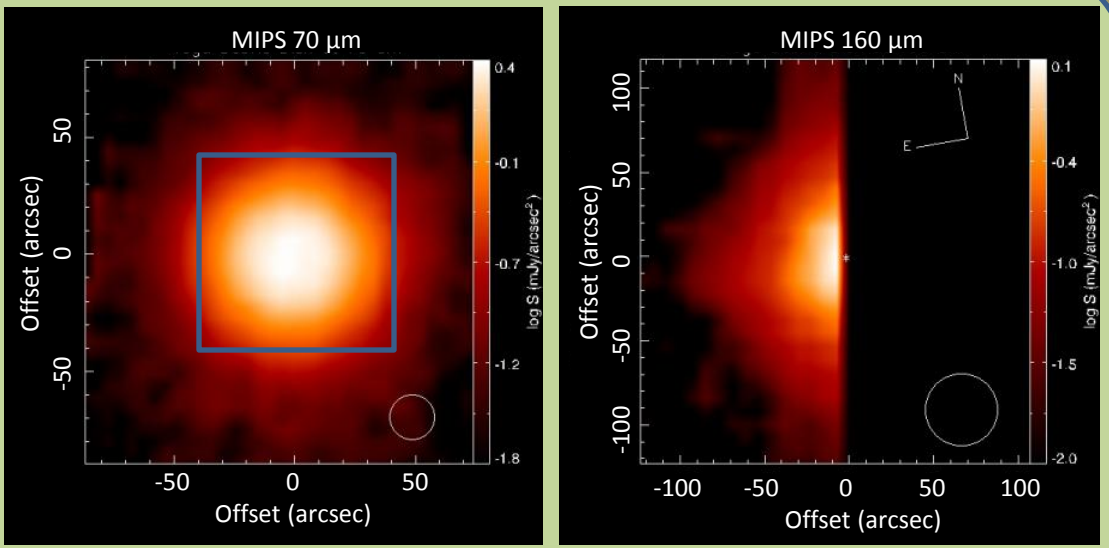




PACS

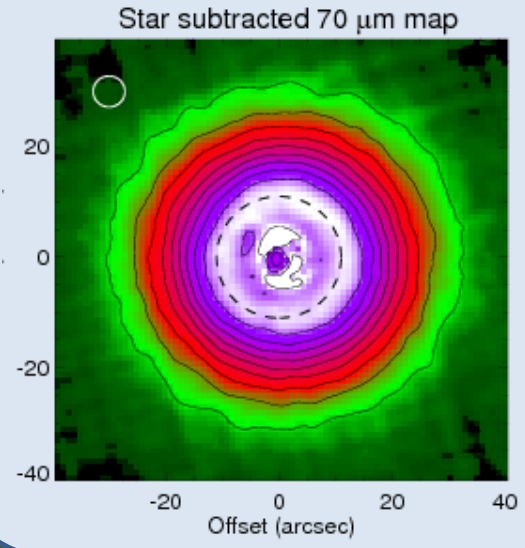


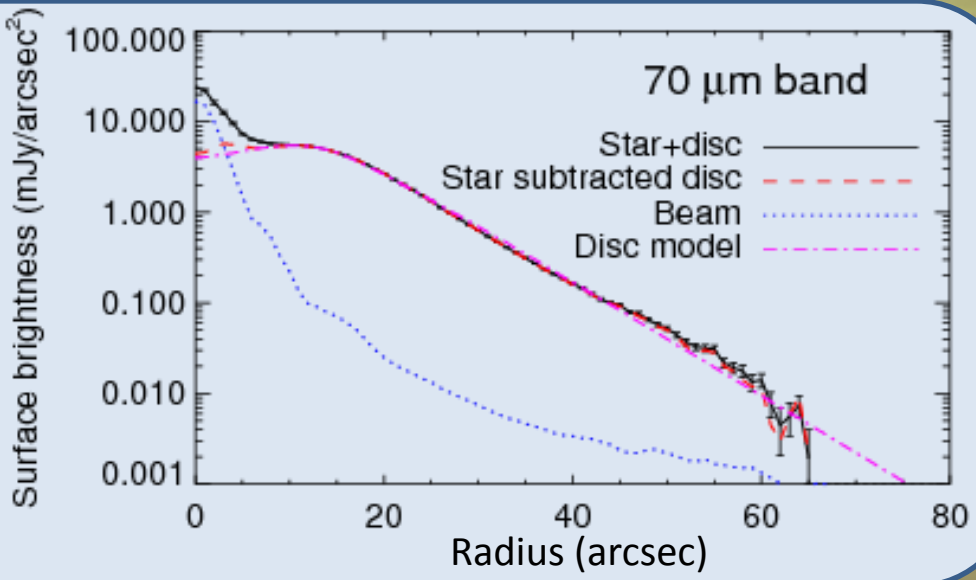
Spitzer/MIPS



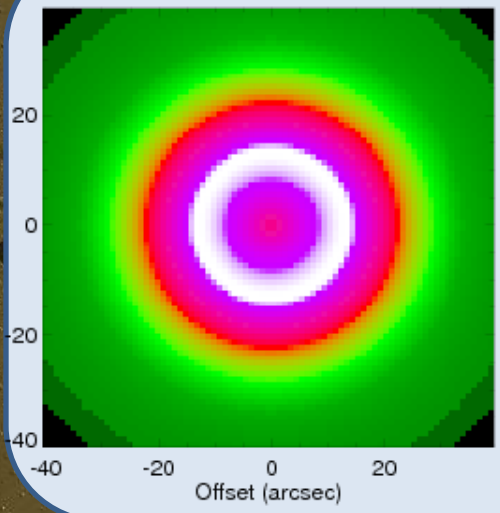
Su et al. 2005

Analysis of 70 µm image

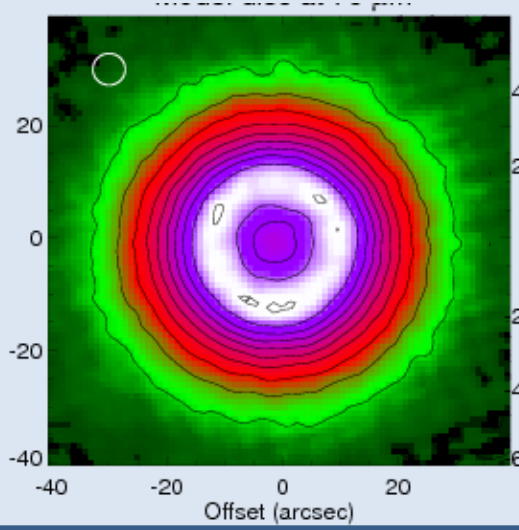




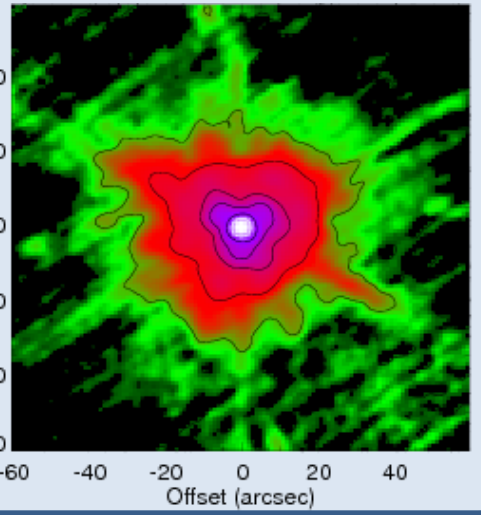
Unconvolved Model



Beam Convolved Model

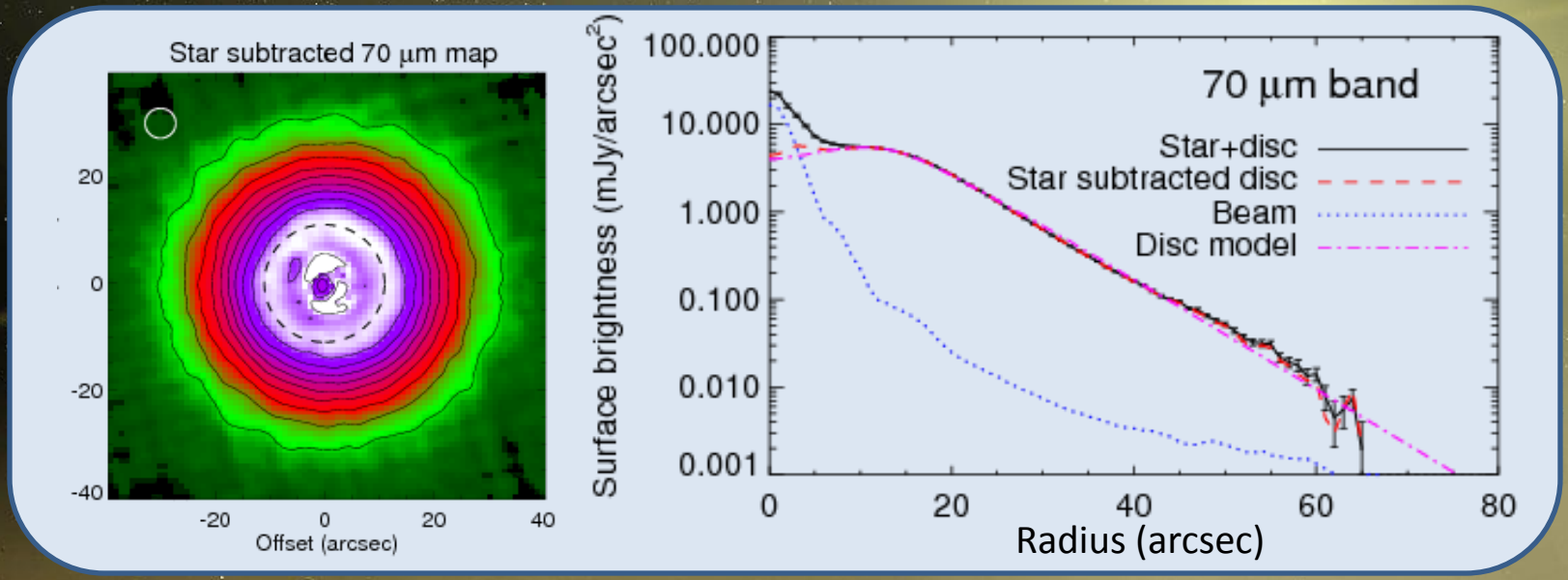


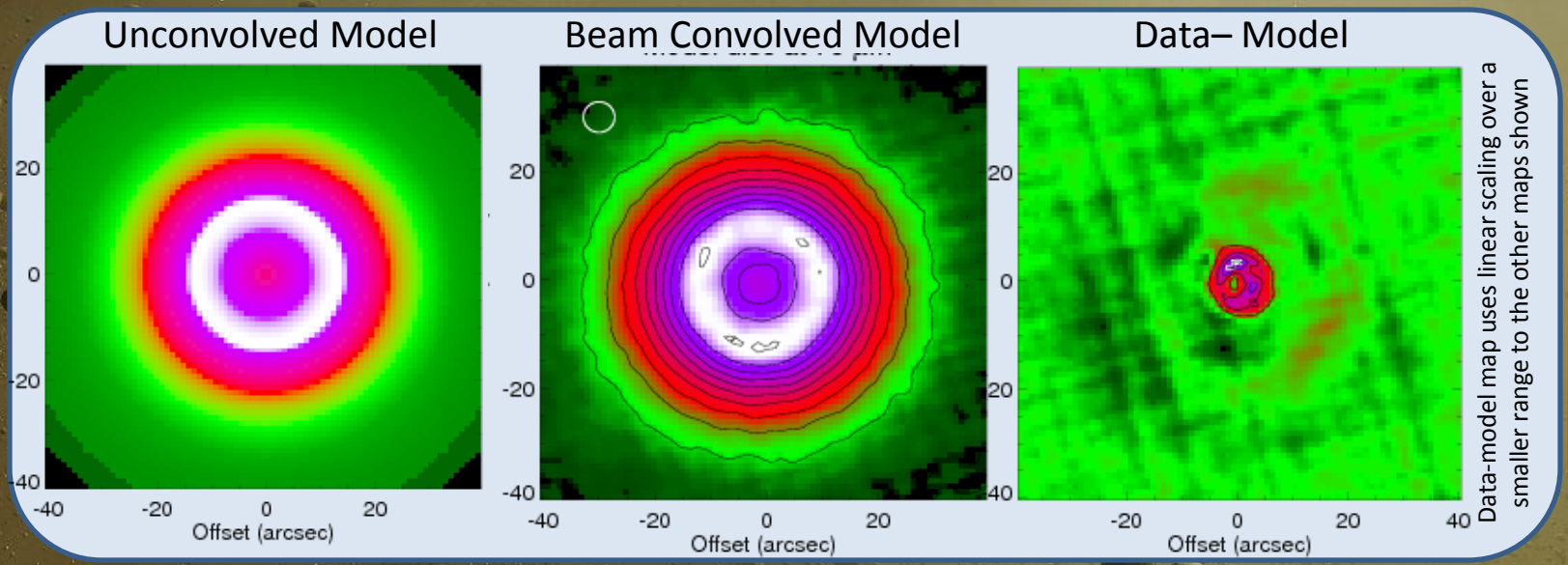
Beam Model (log scaling)



All maps a linearly scaled except beam map which is log scaled

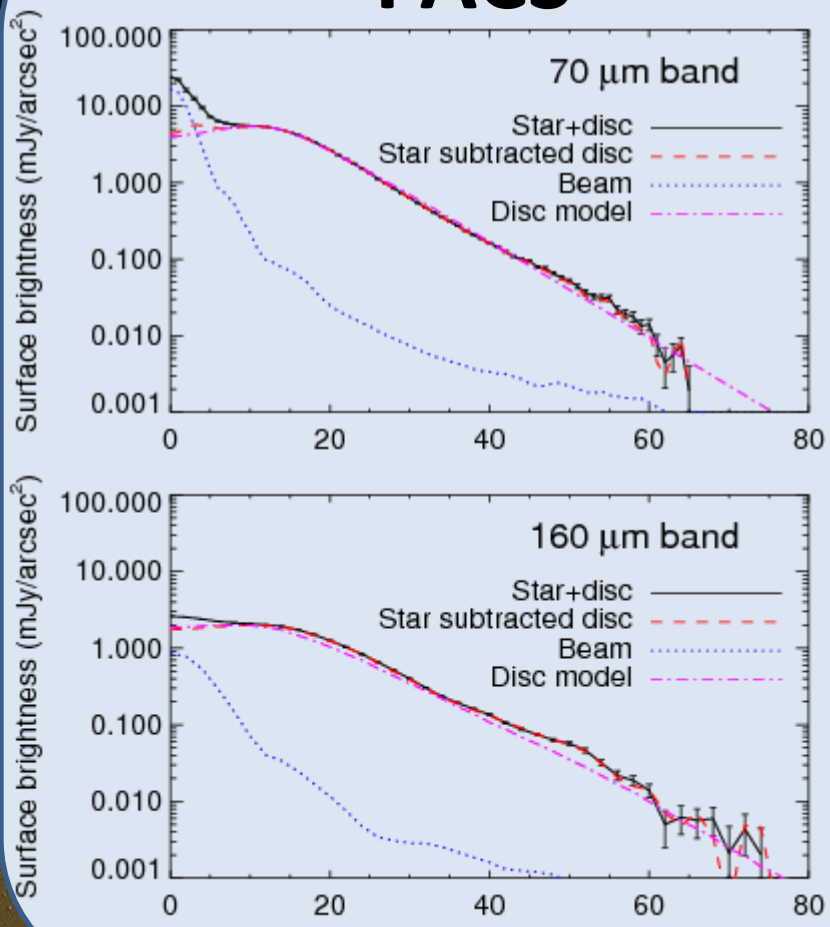
Analysis of 70 µm image



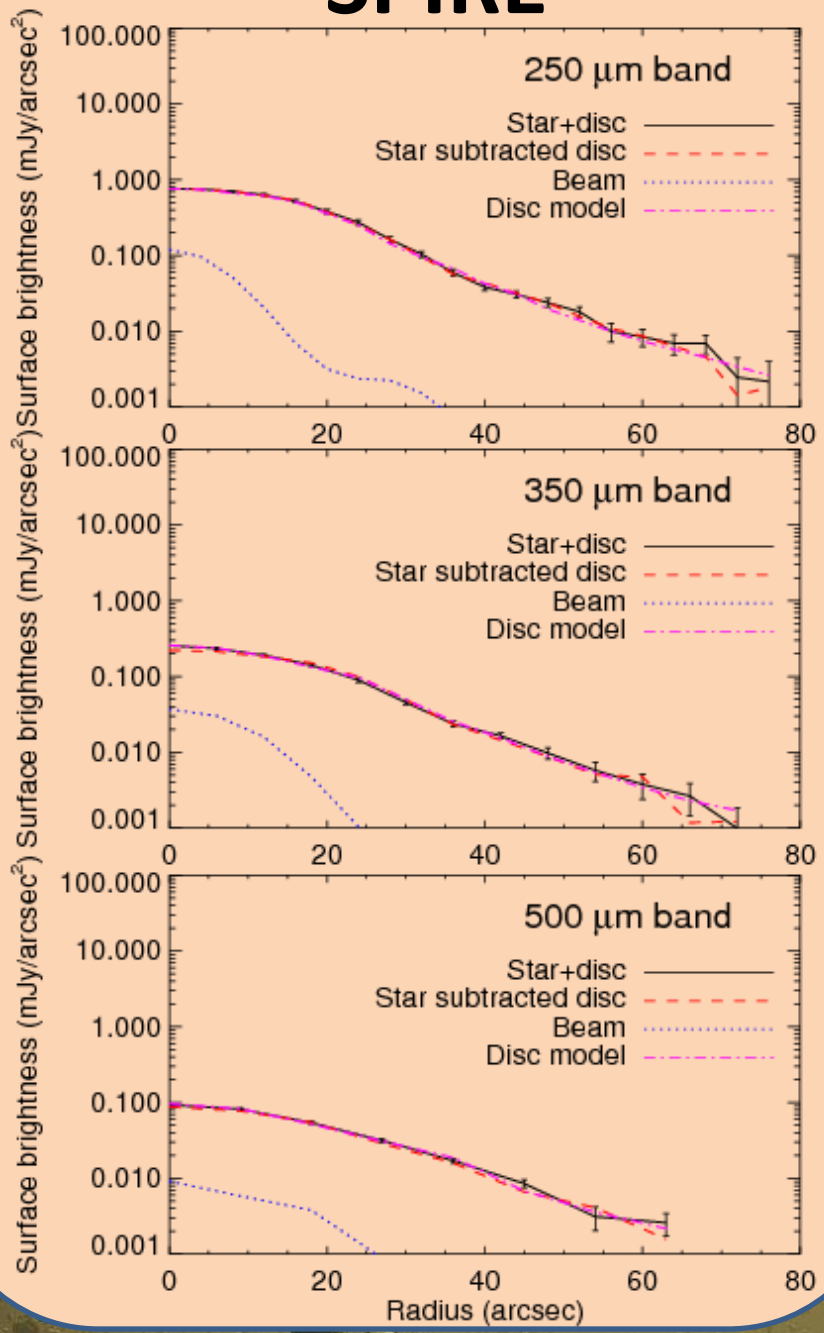


Radial Profiles

PACS



SPIRE



Conclusions

- Clearly resolved disc round at a radius of 11” (~85 AU) at 70 and 160 µm
- Smooth axisymmetric disc structure with no clear clumps
- No evidence for spiral arms originating from clumps observed in the sub-mm
  - Supports the steady state over the ephemeral state, e.g. Müller et al. 2010
- Single underlying surface brightness model found to fit radial profiles for all Herschel bands