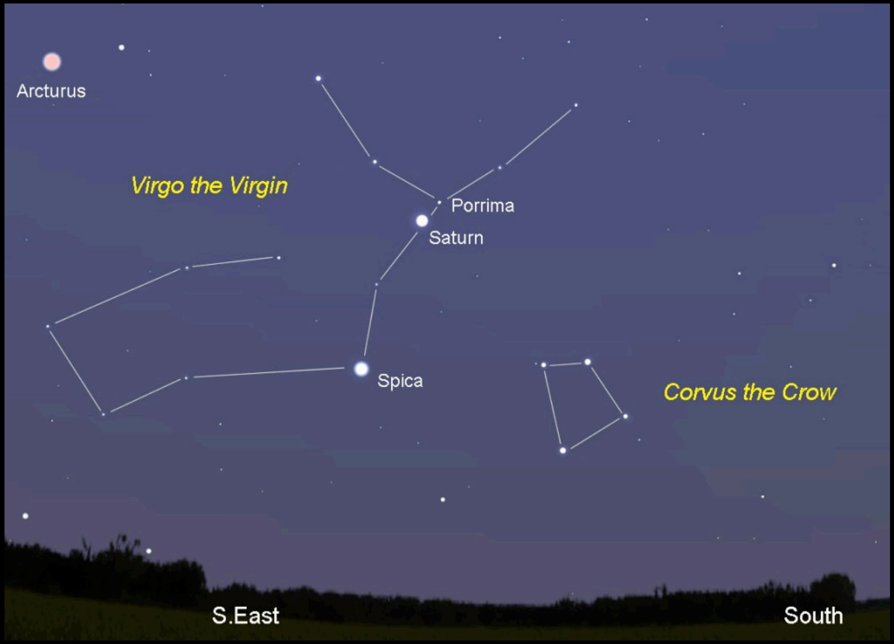
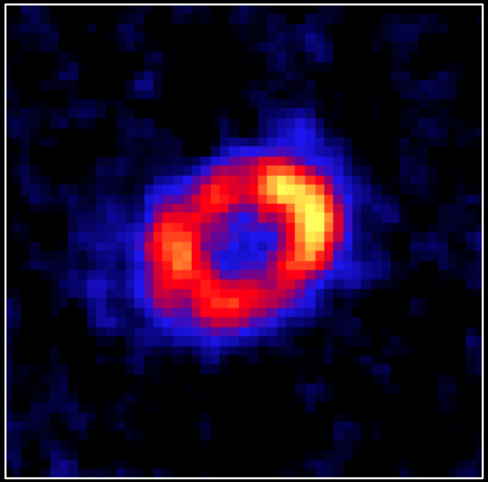




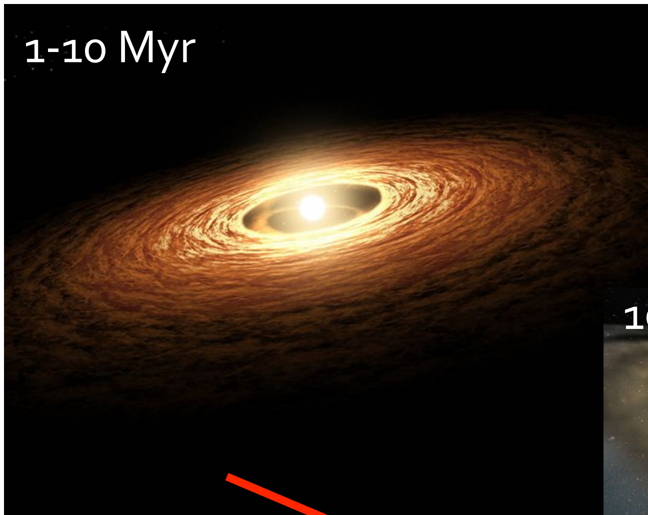
The *Herschel* view of a remarkable Gyr-old two-belt debris disk (η Crv)

Gaspard Duchêne

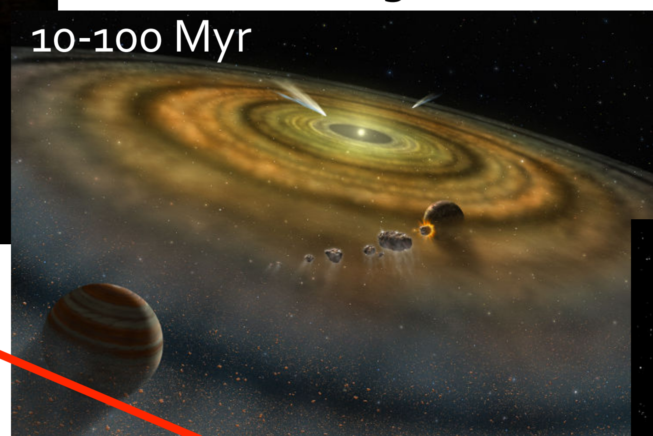
P. Arriaga, M. Wyatt, G. Kennedy, B. Sibthorpe, C. Lisse, W. Holland, J. Wisniewski, M. Clampin, P. Kalas, D. Wilner, M. Booth, J. Horner, B. Matthews, J. Greaves

The stages of planetary systems

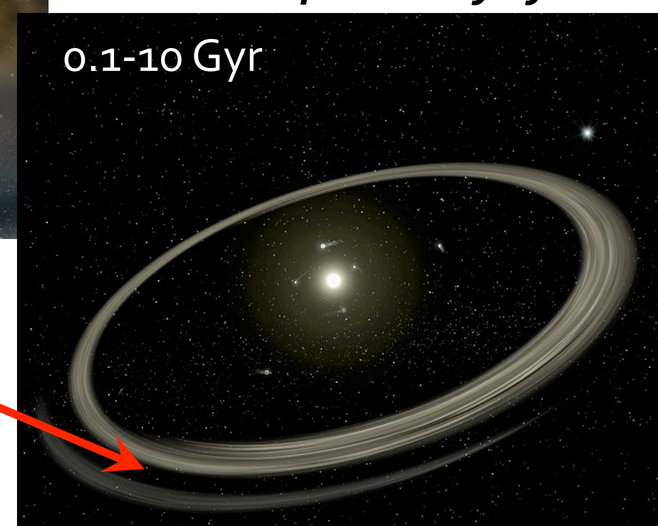
Protoplanetary disk



Young debris disk

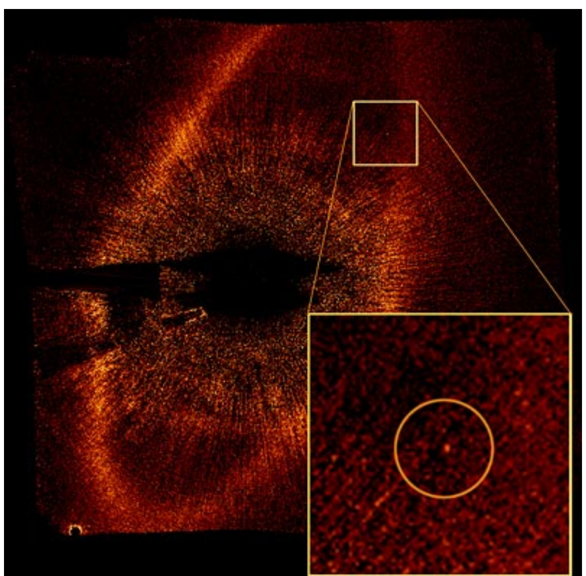


Mature planetary system

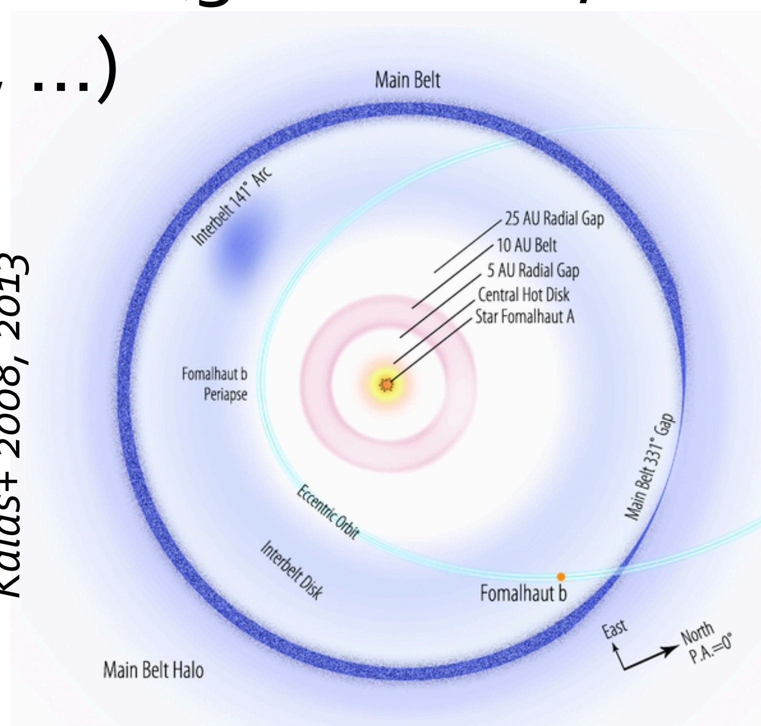


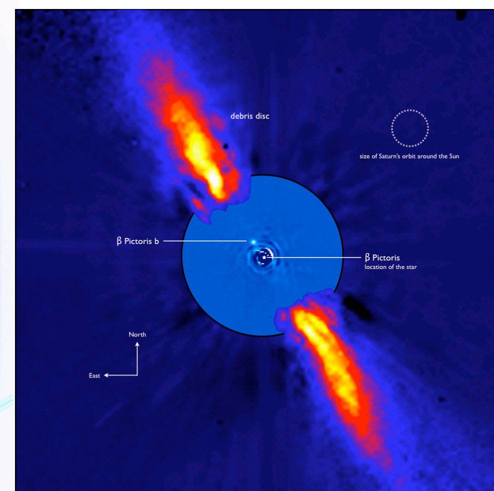
Insights from debris disks

- Location of remaining planetesimals
  - Truncation/shepherding by (unseen) planets
- Balance of forces (gravitation, radiation, stellar winds, …)



Kalas+ 2008, 2013





Lagrange+ 2008

Multi-belt debris disks

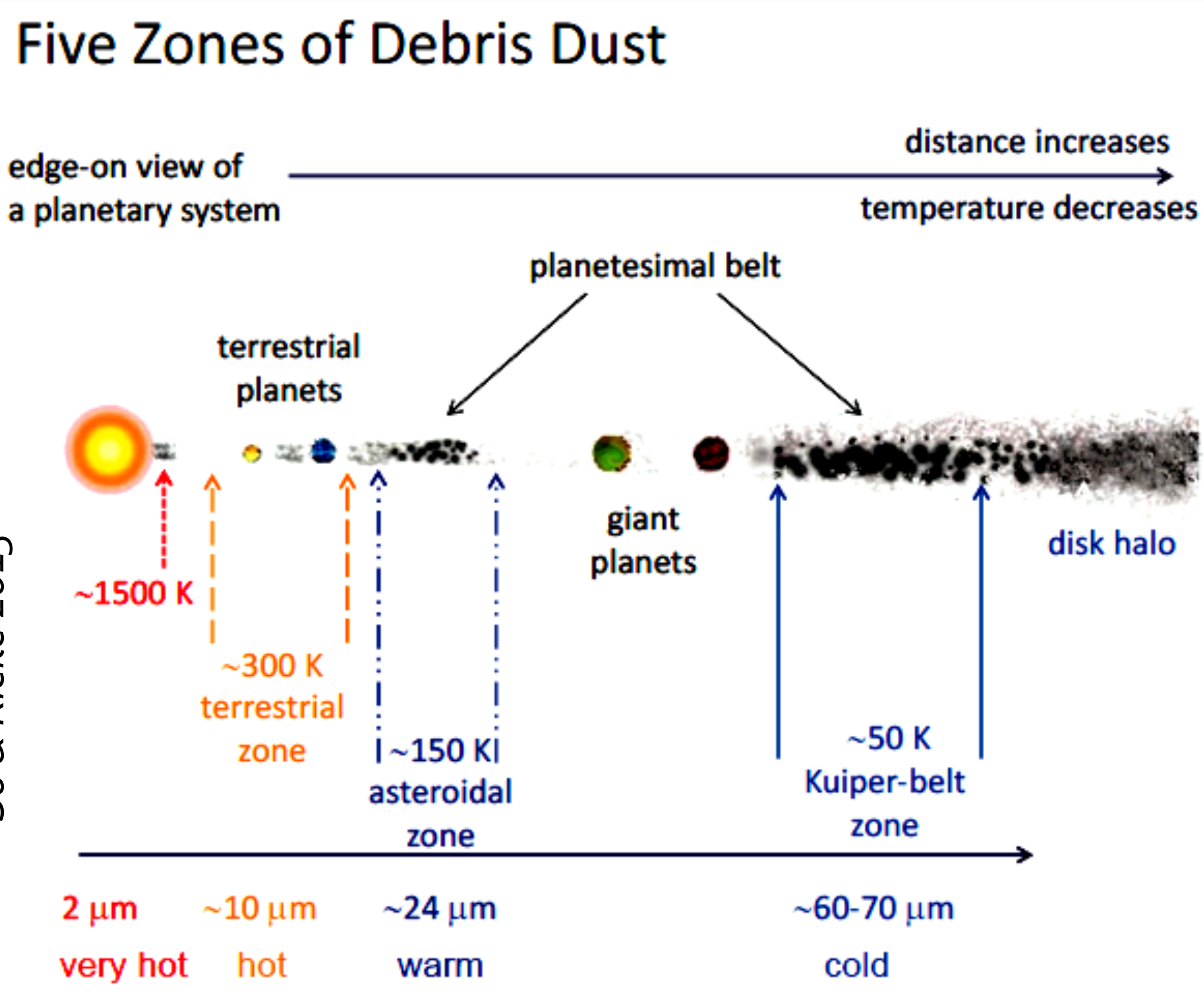
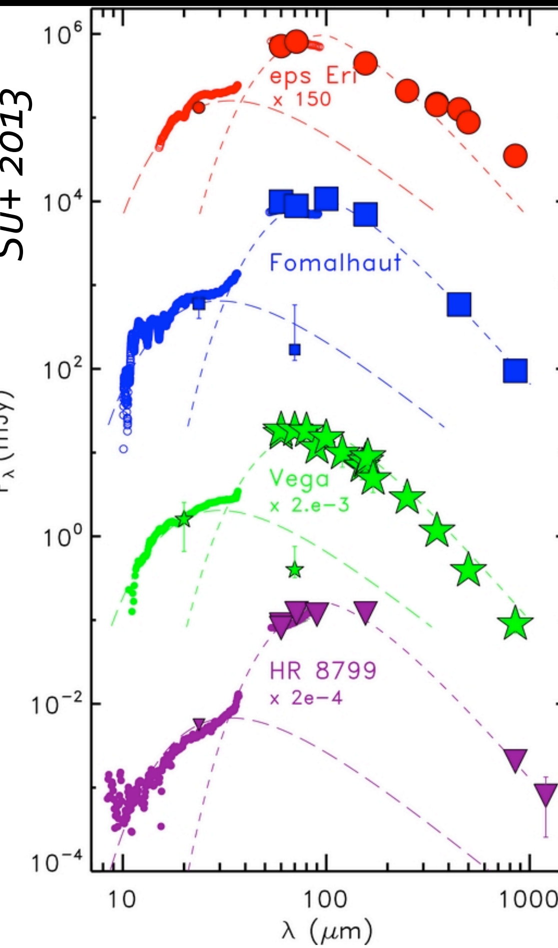


Figure 1. Illustration for the five zones of debris dust.

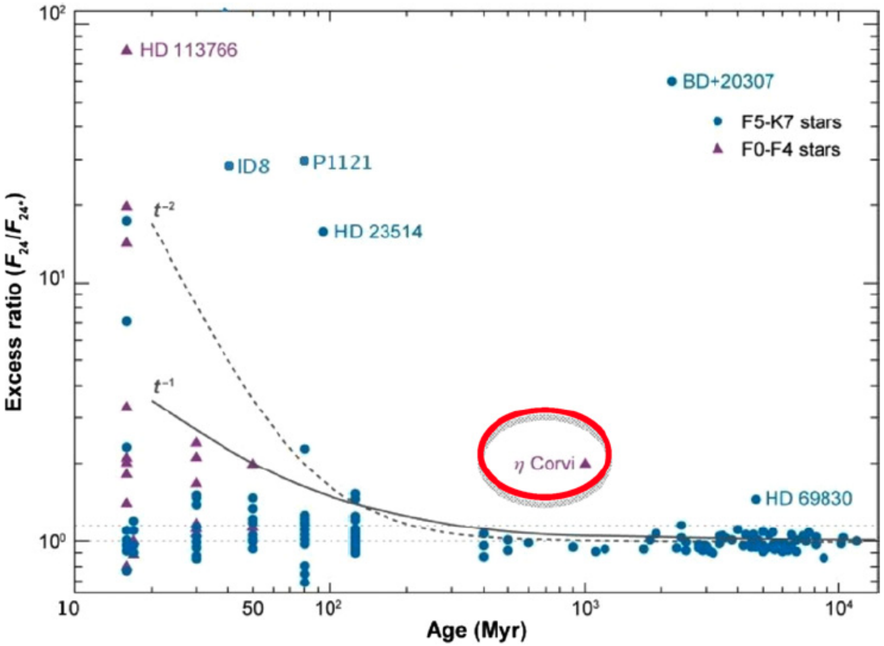
Su & Rieke 2013



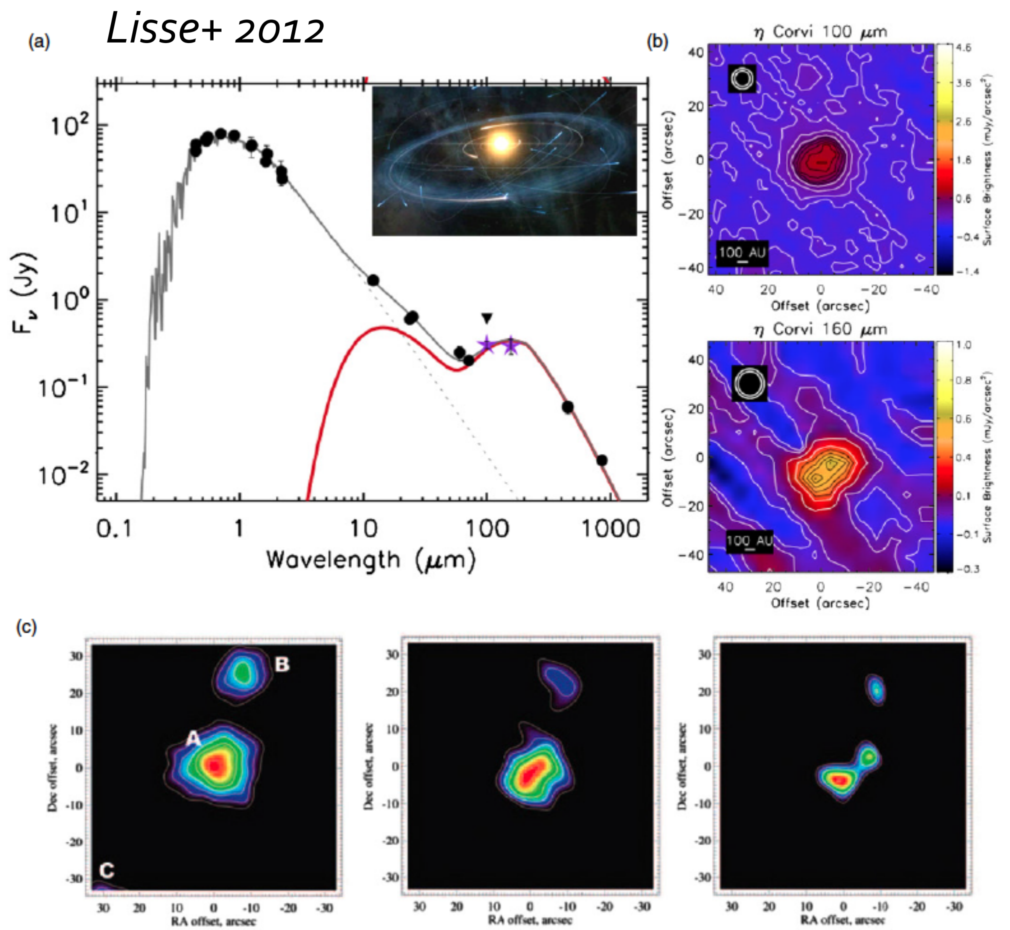
Su+ 2013

A common outcome but what is the link between the belts?

Eta Crv: prior knowledge

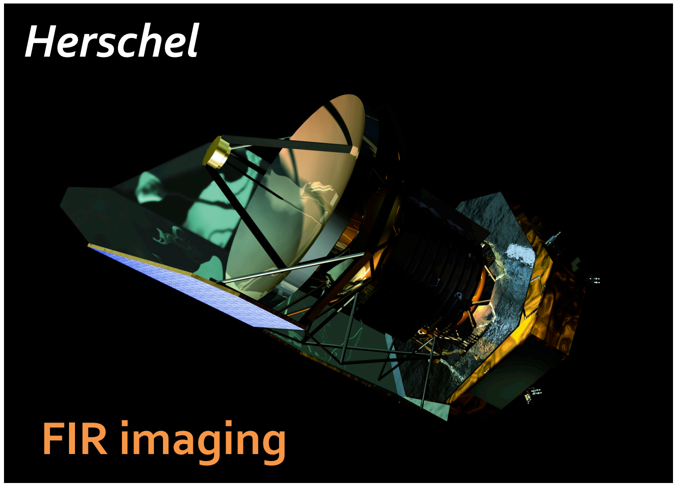


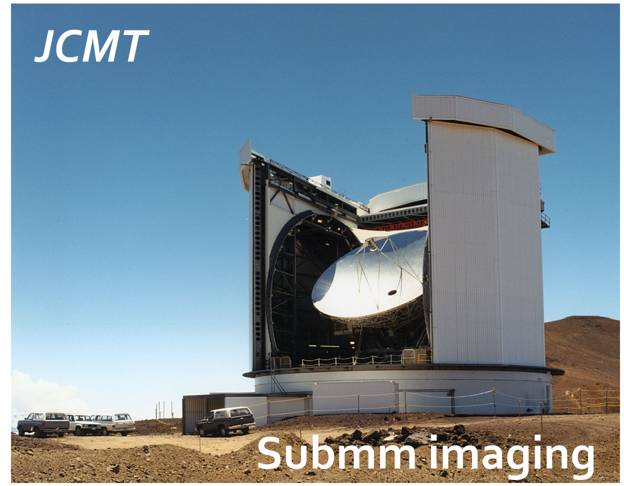
Lisse+ 2012

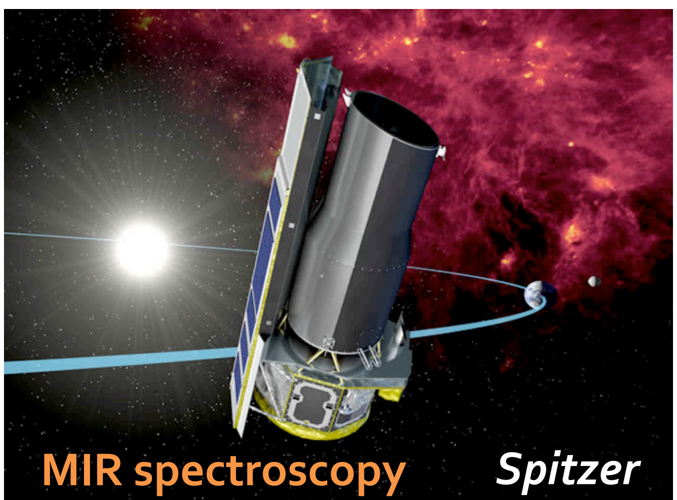


- A nearby F2 star (18.3 pc)
- An old star (1-2 Gyr)
- A two-belt system
- A resolved "cold" belt (~150 AU)
- An exceptionally bright "warm" belt (< 3 AU)

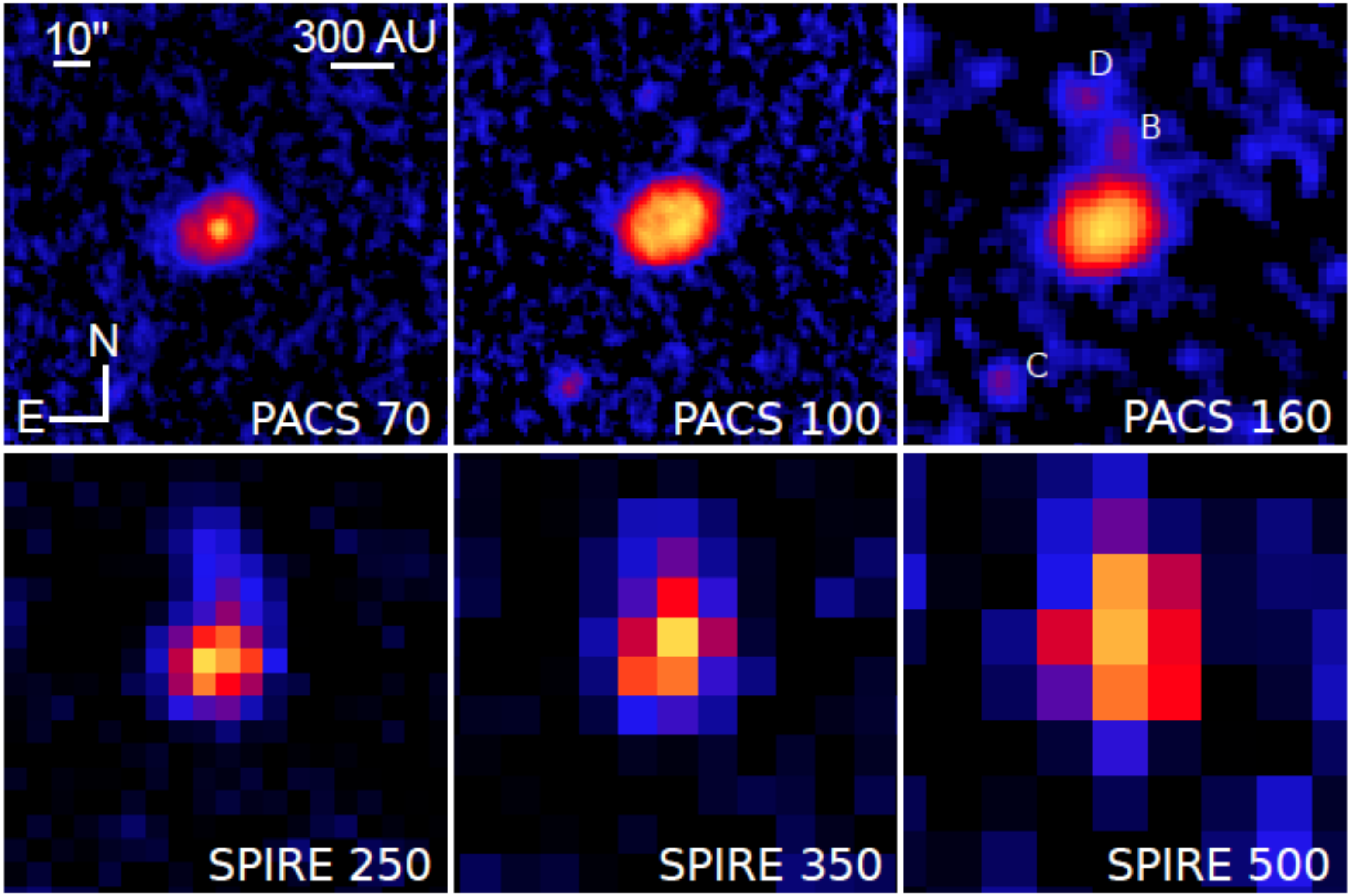
New observations



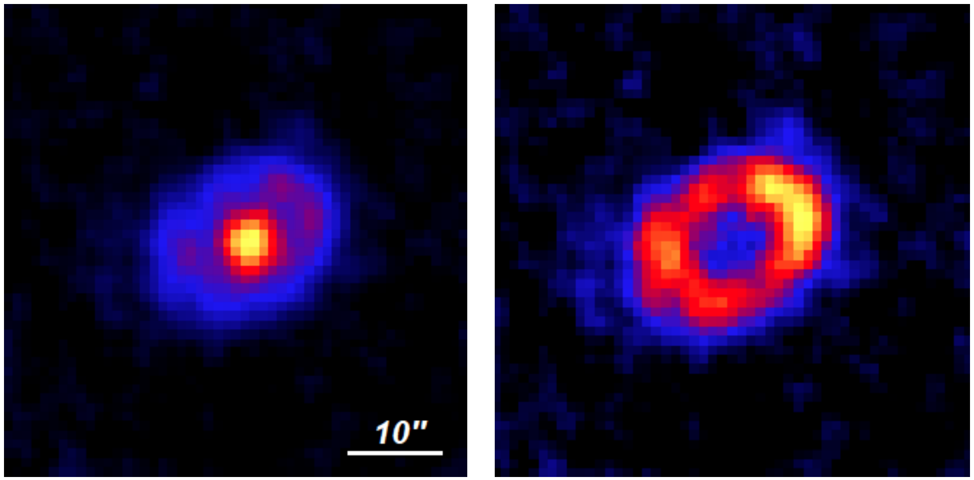


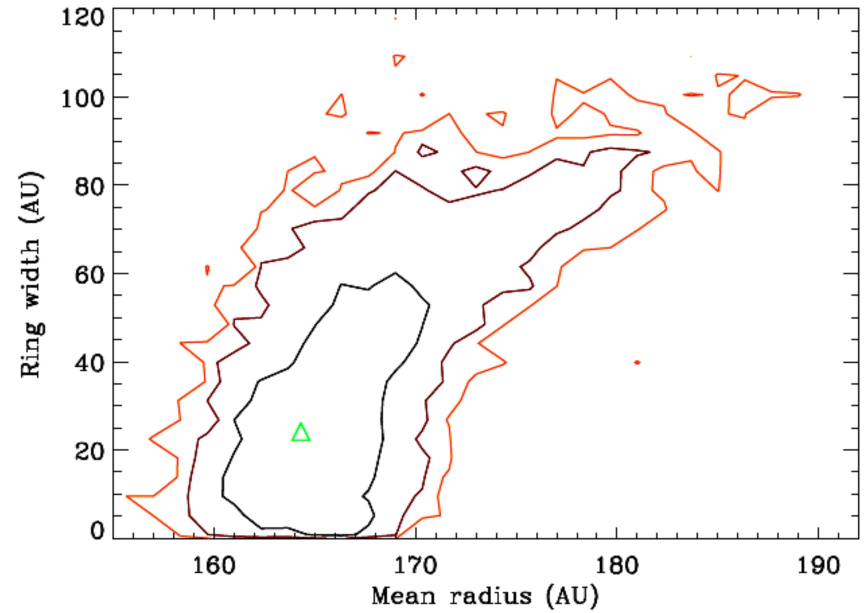


Herschel high-resolution images



Herschel high-resolution images





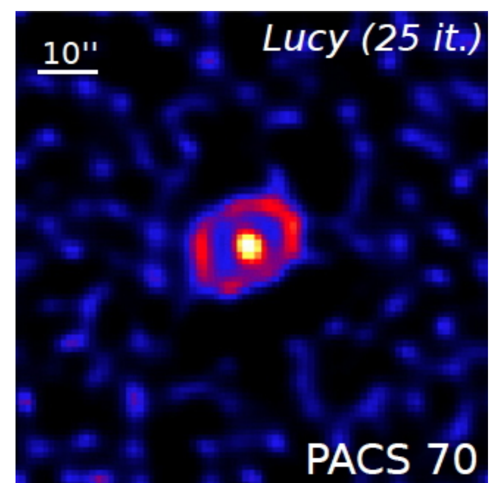
Central point source brighter than stellar photosphere

Detection of "warm belt" at 70 μm

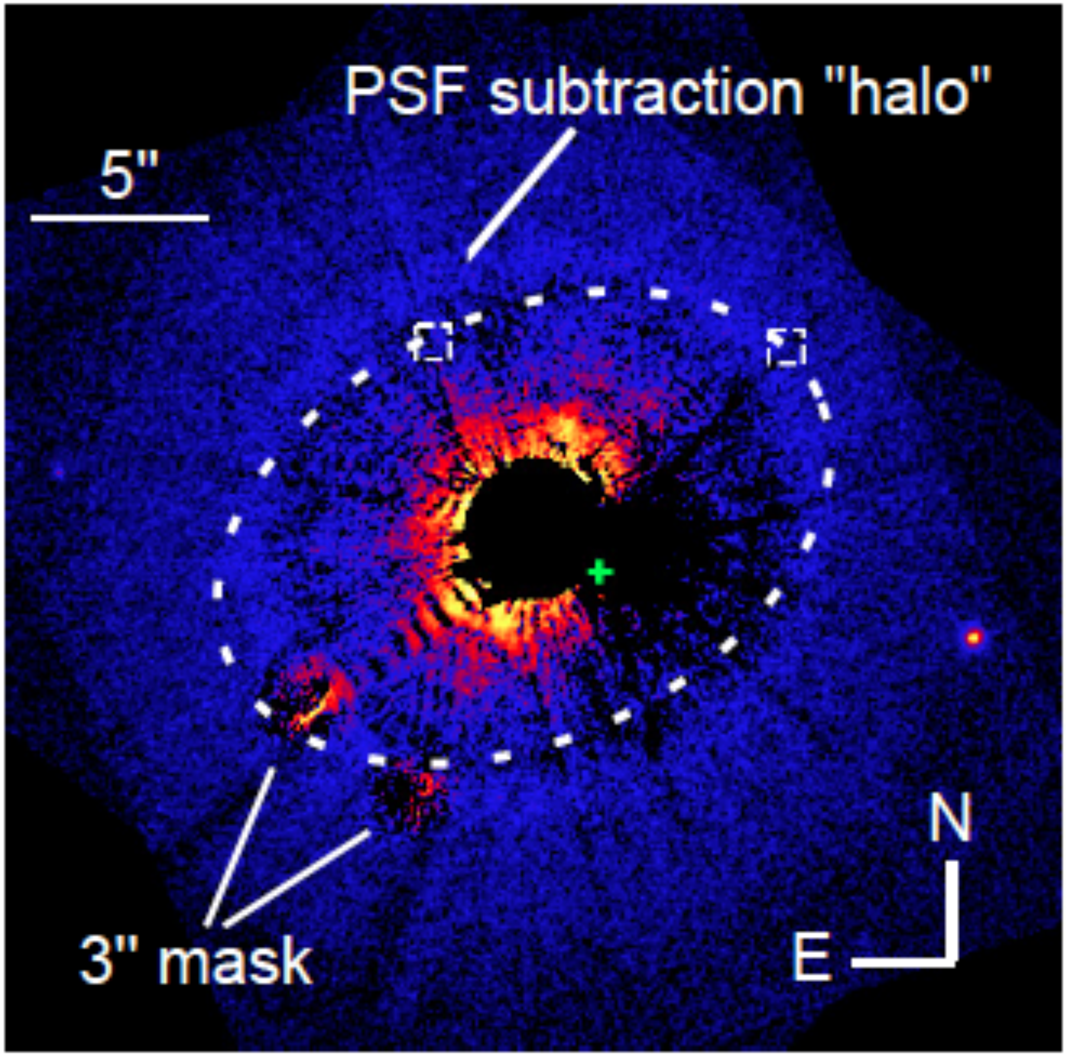
Outer ring radius ~ 2x prediction from T_{BB}

Outer ring width partially constrained (< 75 AU)

Possible offset from star (10-15 AU)



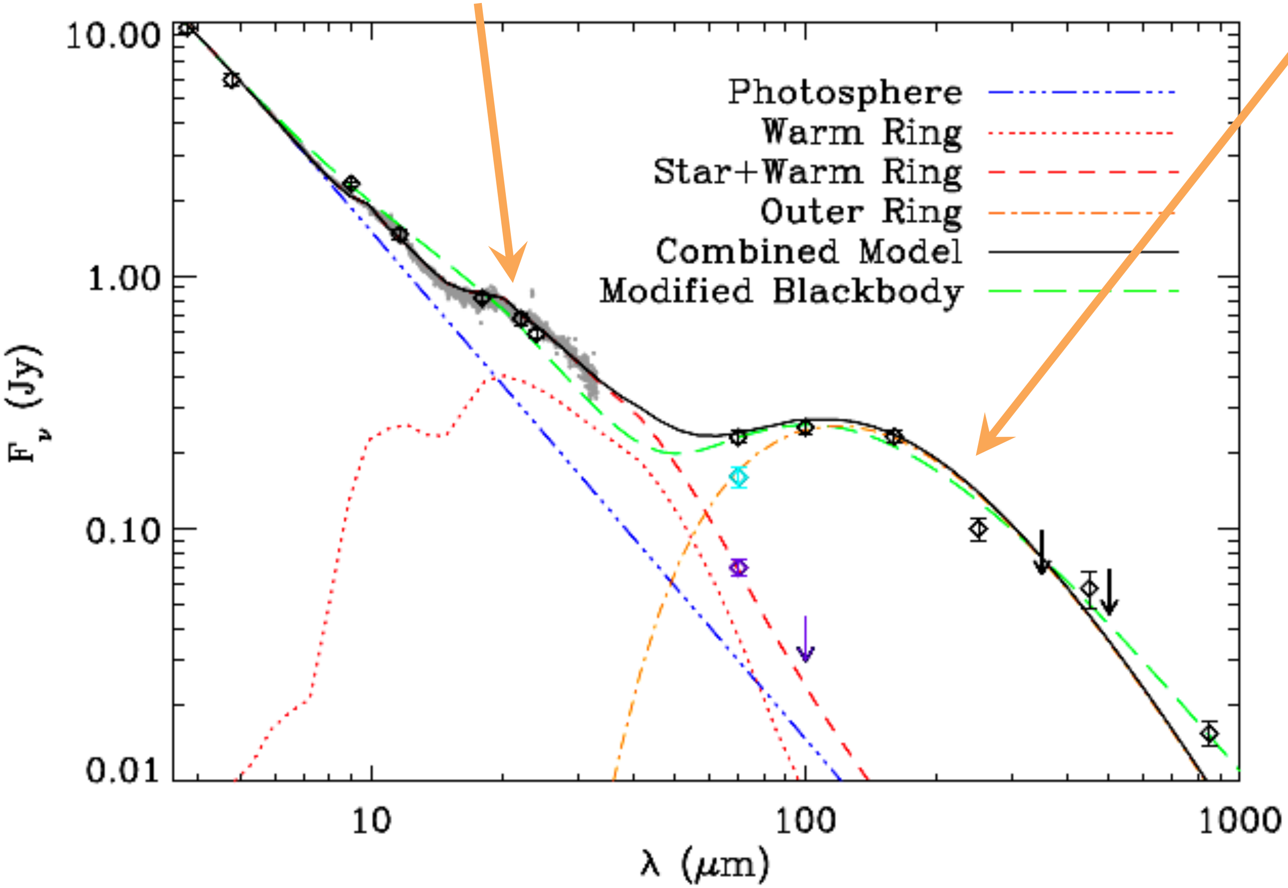
Scattered light non-detection



Complete SED

T = 409 K; $M_{dust} \approx 4\ 10^{-6}\ M_{\oplus}$

T = 42 K; $M_{dust} \approx 0.025\ M_{\oplus}$



Temperature

+

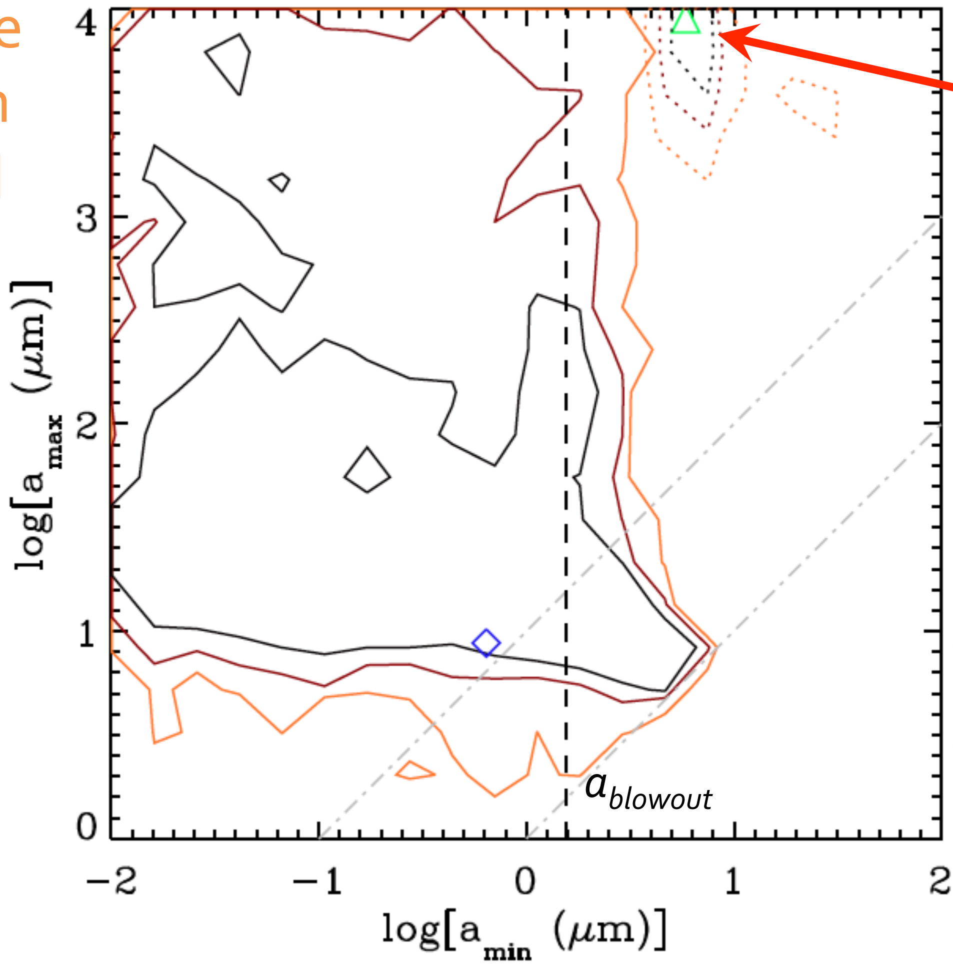
Location

Dust properties

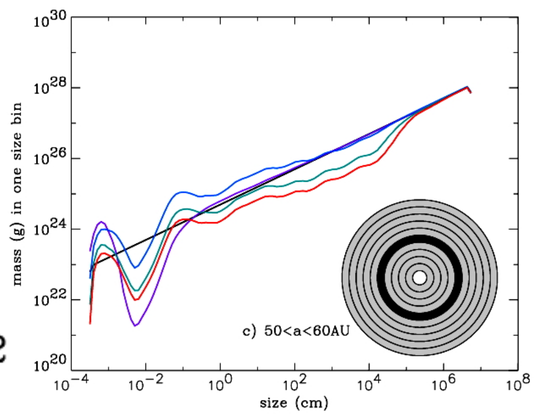
(size, composition)

Constraining dust properties

Assuming same composition in both belts and N(a) ≈ $a^{-3.5}$



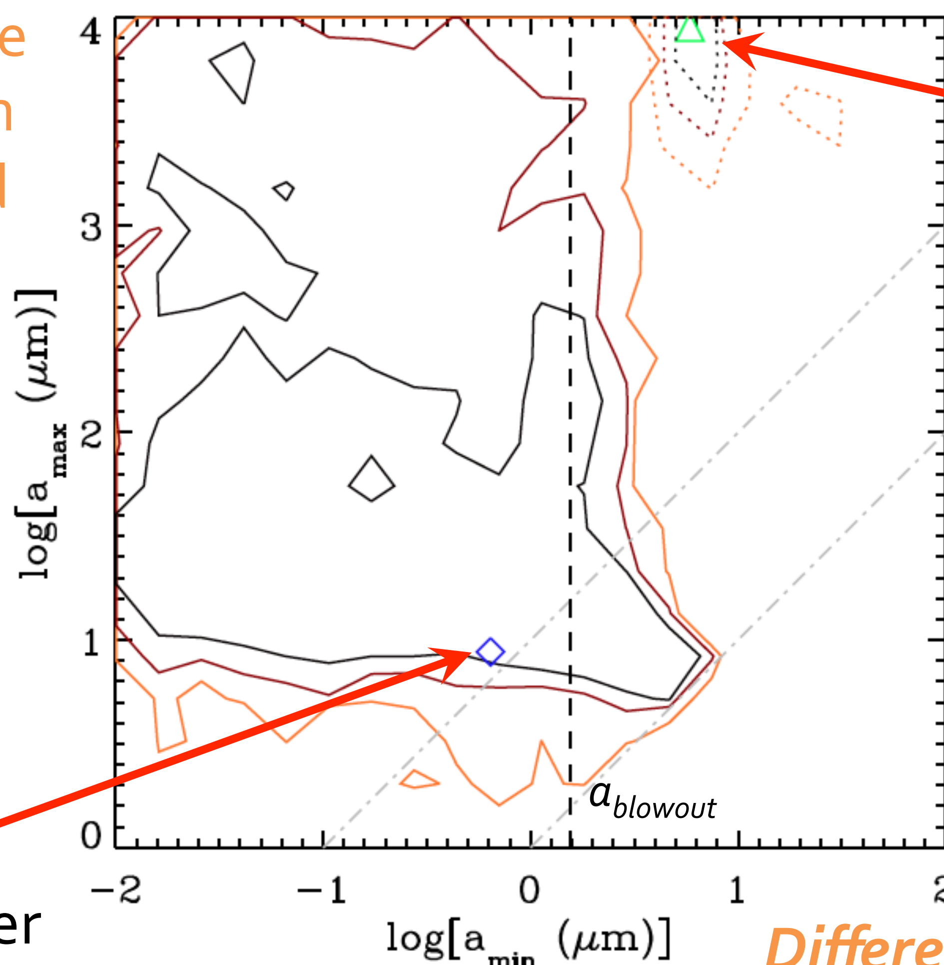
Outer belt: Collisional cascade (deviation from pure power law) or lack of small dust grains?



Thébaut+ 2007

Constraining dust properties

Assuming same composition in both belts and N(a) ≈ $a^{-3.5}$



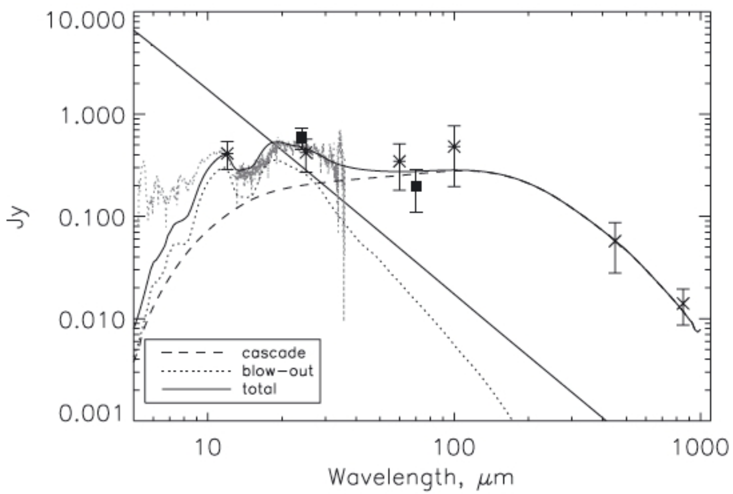
Outer belt: Collisional cascade (deviation from pure power law) or lack of small dust grains?

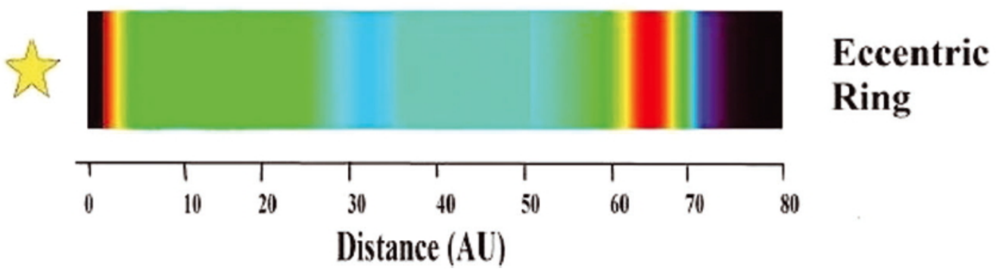
Inner belt: Grains smaller than blowout size?

Different dust populations In the two belts!

Implications (I)

- Lifetime of inner belt << system's age
  - Not the steady-state decay of an initial ring
  - No significant change in 30 yr (tens of t_{dyna})
- Different dust populations in the two belts
  - Not a single belt (planetesimals on eccentric orbit)



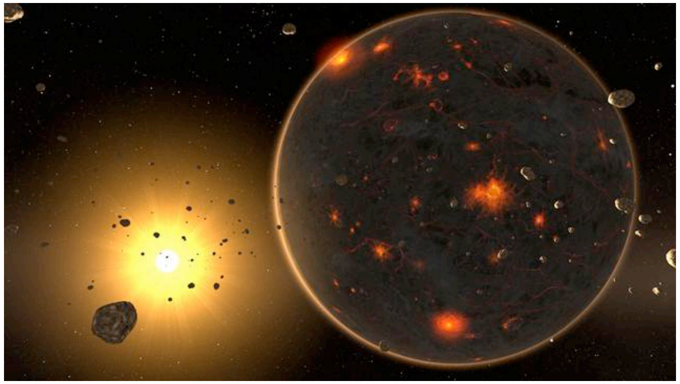


Wyatt+ 2010; Churcher+ 2012

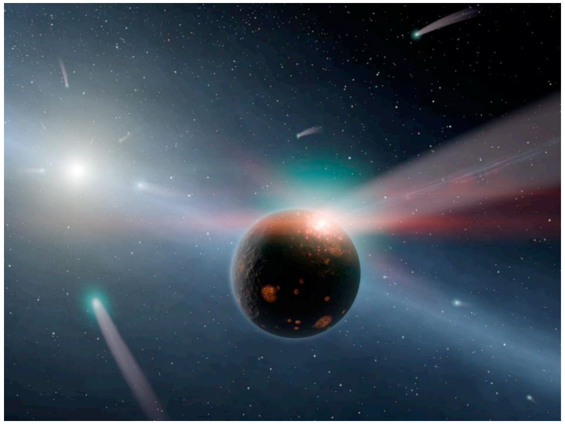
Implications (I)

- Lifetime of inner belt << system's age
  - Not the steady-state decay of an initial ring
  - No significant change in 30 yr (tens of t_{dyna})
- Different dust populations in the two belts
  - Not a single belt (planetesimals on eccentric orbit)
  - Simple drag from the outer belt to the inner belt requires size sorting & a halting mechanism
- Ring offset suggests underlying planetary system still to be found

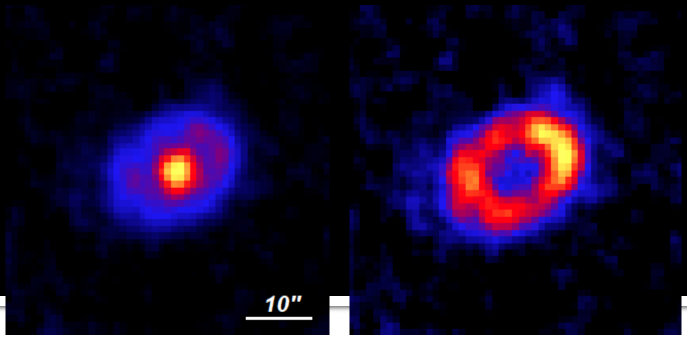
Implications (II)



- Origin of inner belt?
  - One-off event?
    - Giant collision
    - LHB-like event
  - Steady feeding by comets, followed by sublimation to produce small (ice-rich) dust?
    - “rain of comet”
- No clear-cut argument for now



Summary



- The Eta Crv debris disk consists of two distinct belts, physically and in their dust content
- The outer belt is consistent with a normal decay of a rich initial reservoir of planetesimals
- The origin of the inner belt remains unclear
  - Recent low-probability event?
  - Steady rain of comets?
- TBC with new ALMA, IR interferometric data…

Debris disks: HR 4796

Analysis in progress, update soon!