

A dark space background featuring a large, dark planet on the left side and a smaller, cratered planet in the upper right. The background is filled with numerous small white stars and a soft, reddish-pink nebula-like glow.

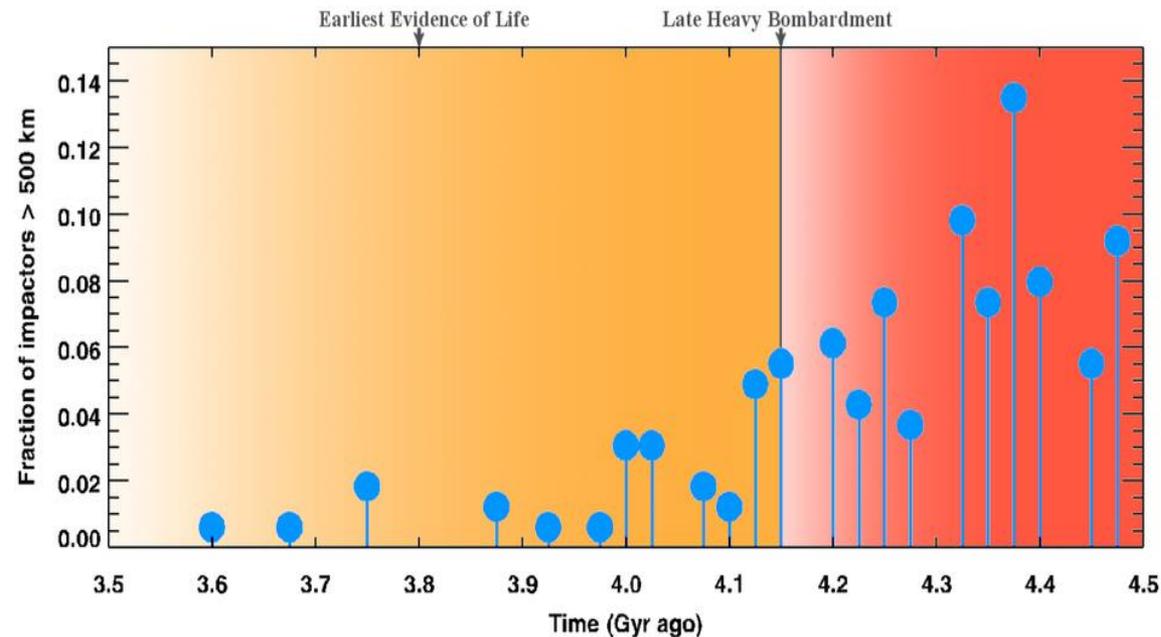
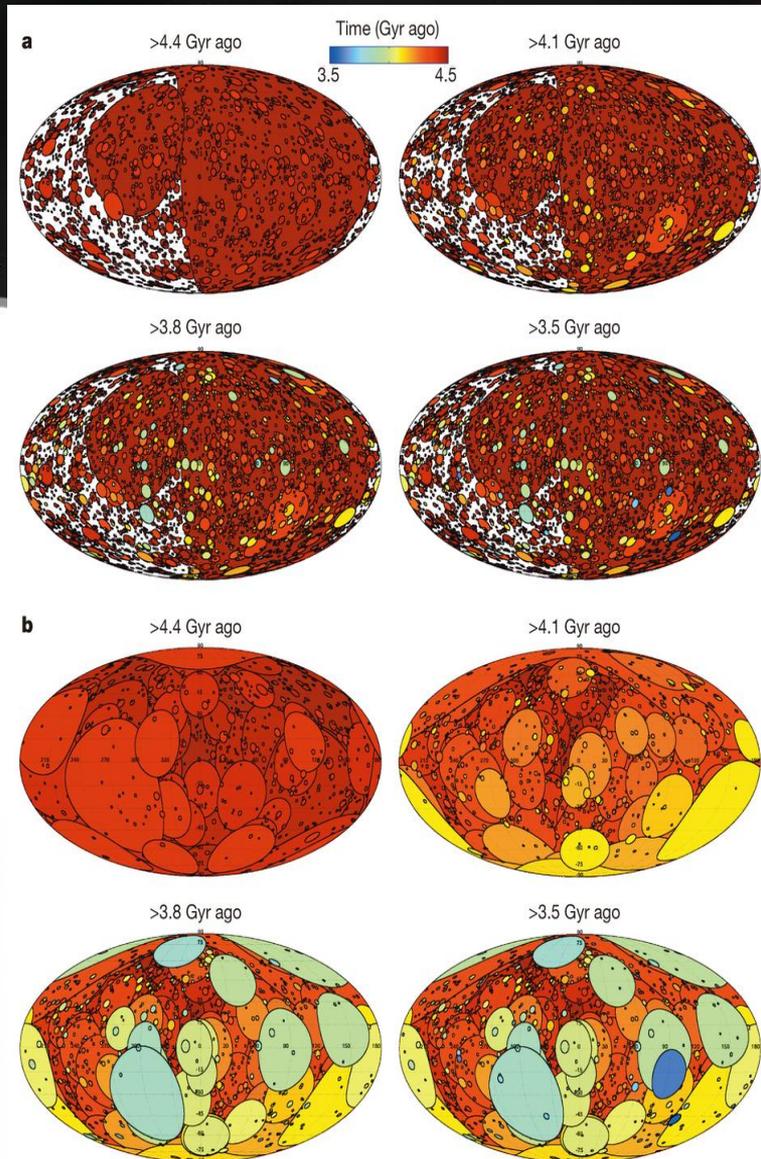
# The Impact Story for Exo-Earths

Jane Greaves

University of St Andrews, Scotland

# the hostile early Earth

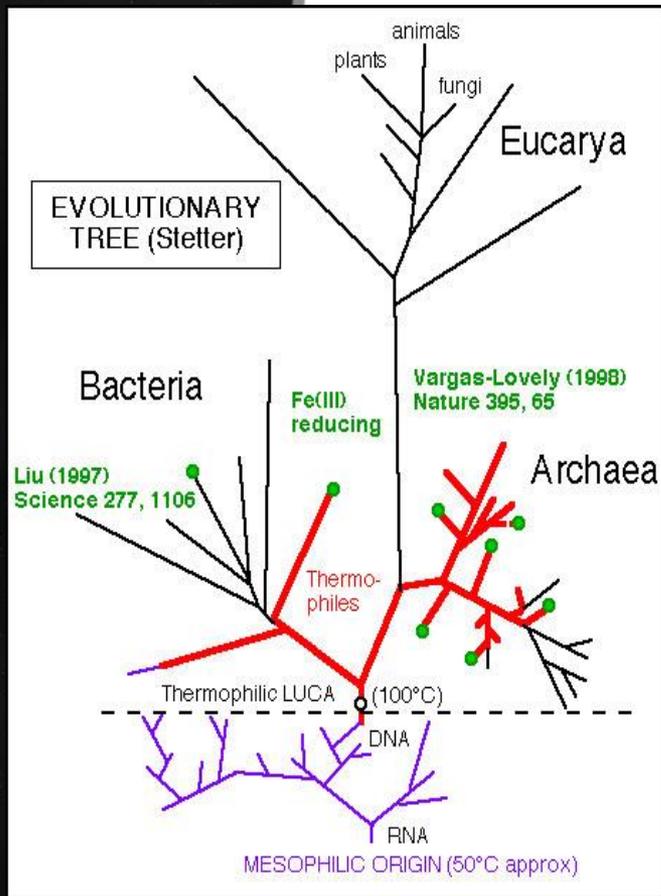
- evidence of life only after heavy bombardment  
(e.g. Marchi et al. 2014)



# impacts and energy for life

- thermal basins (*stability? expansion?*)

(Brochier & Philippe 2002; Flaspohler 2012)



# comet-belt histories

- is the solar system peculiar?

(Booth et al. 2009;  
Walsh et al. 2011)

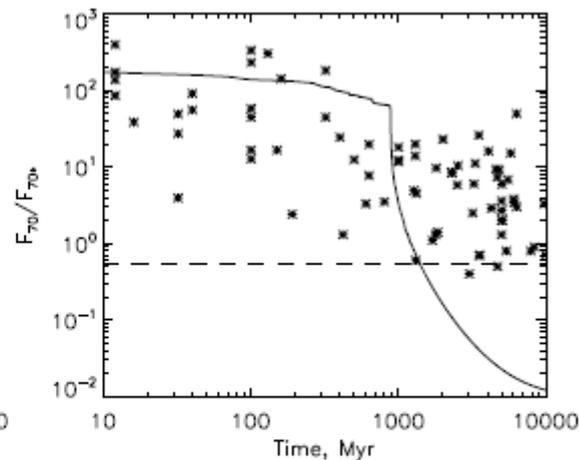
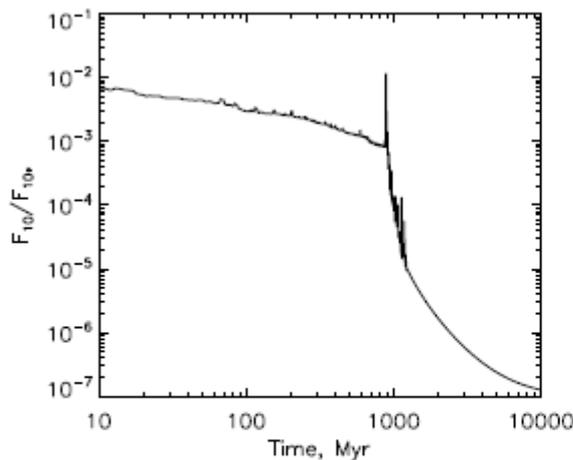
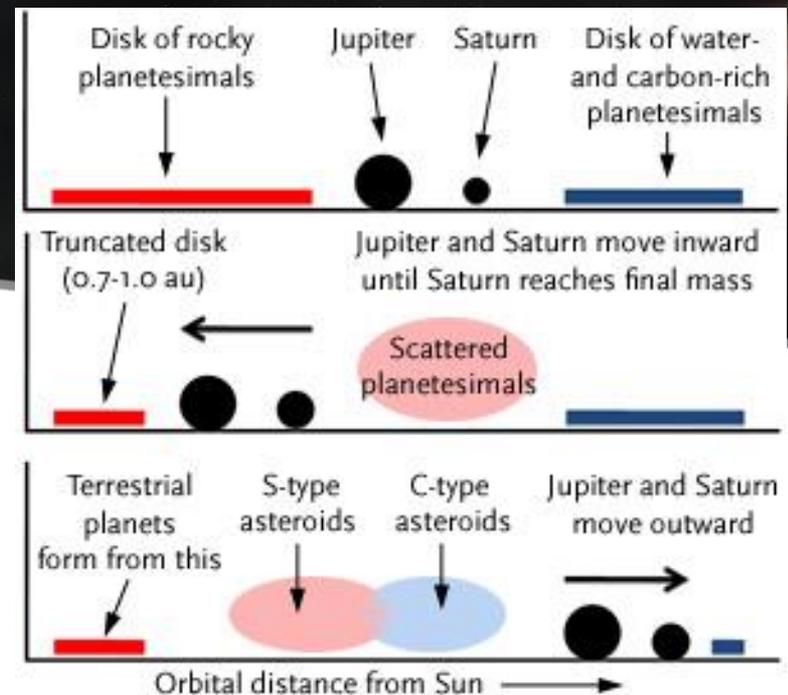
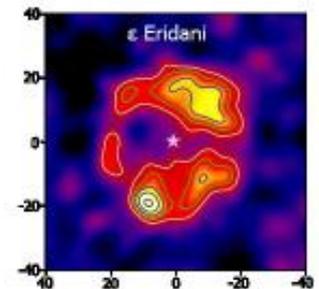
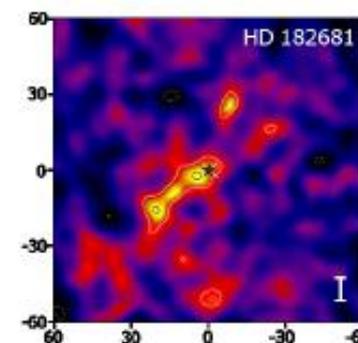
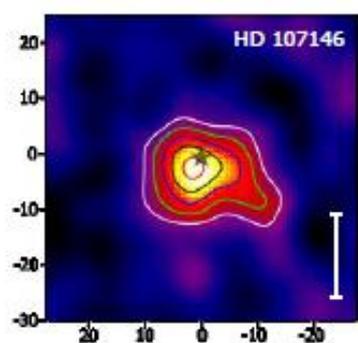
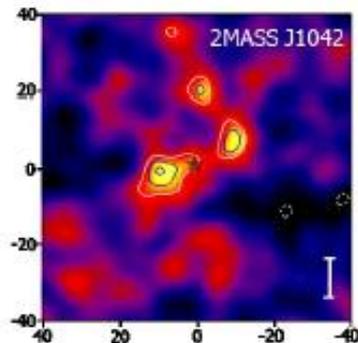
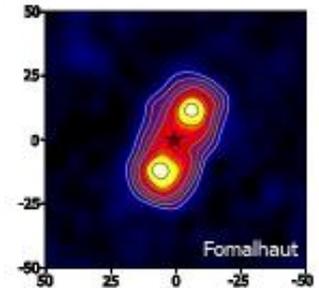
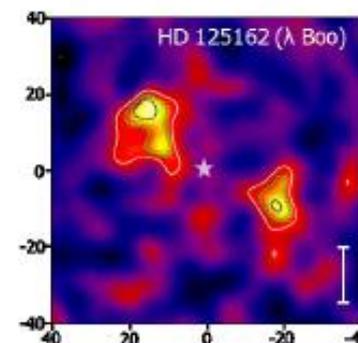
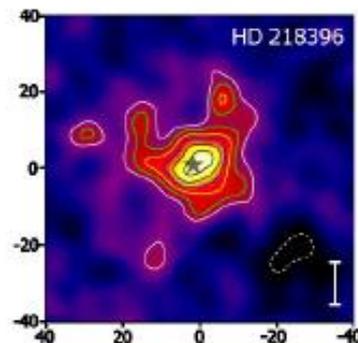
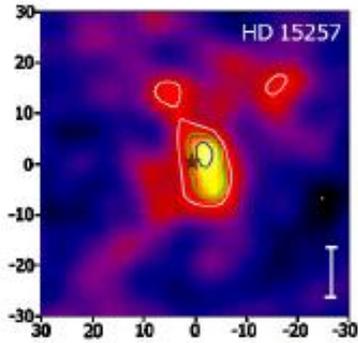
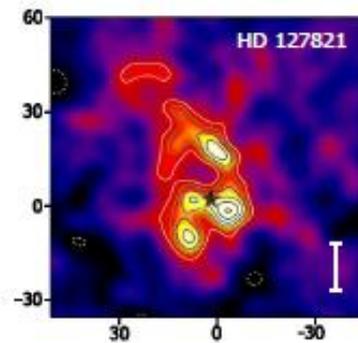
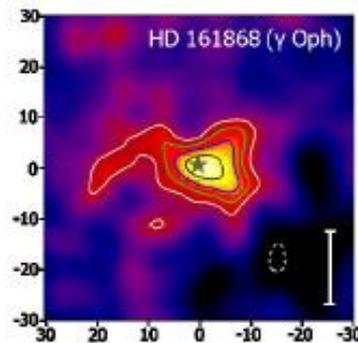
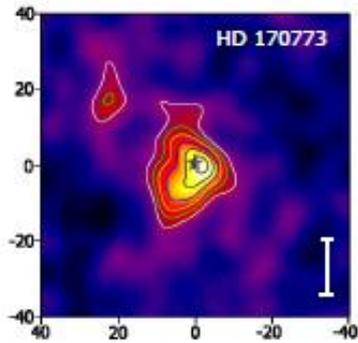
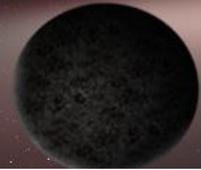


Figure 1. Excess ratio versus time for  $10 \mu\text{m}$  (left) and  $70 \mu\text{m}$  (right). The solid line represents the emission from our model. The asterisks are observed discs and the dashed line shows the approximate observational limit.

# observing exo-comet-belts

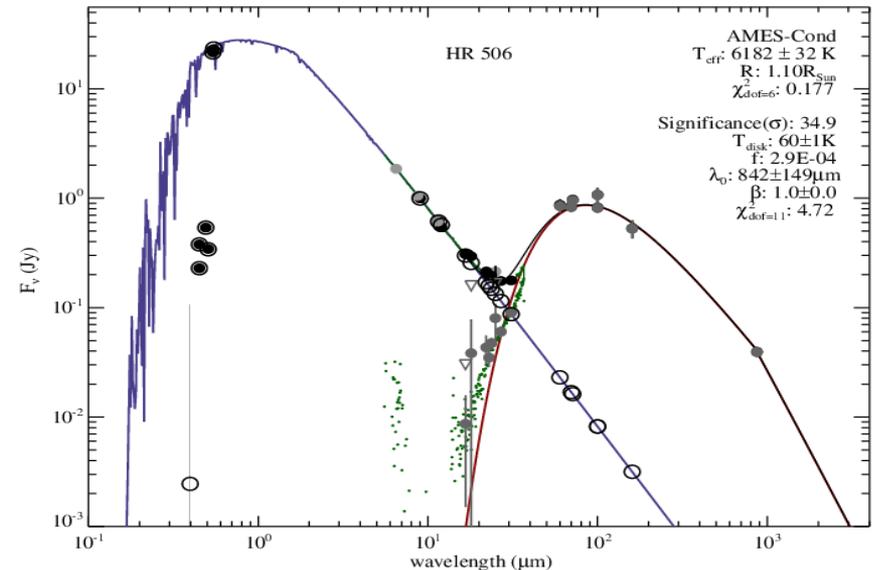
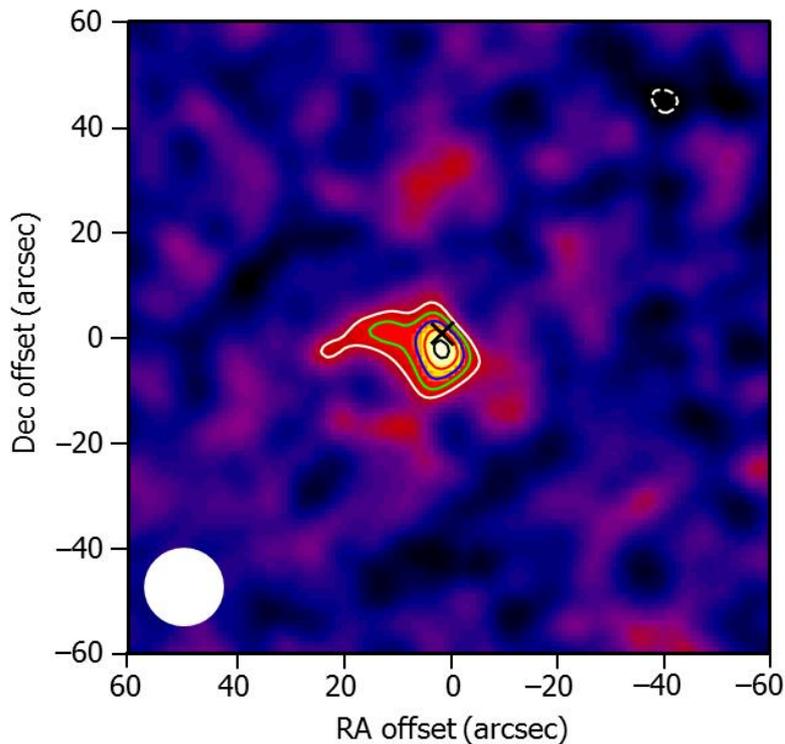


# Survey Of Nearby Stars



# comet belts on steroids...!

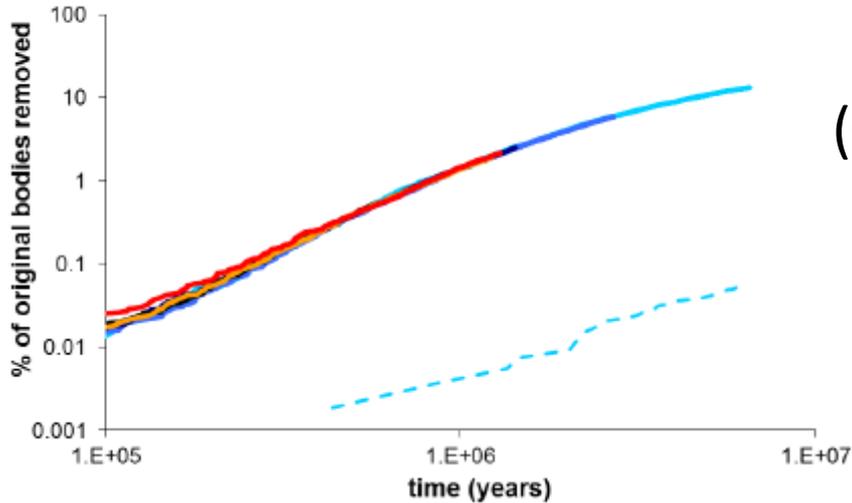
- q1 Eri (HD 10647) (→ Liseau et al. 2008)
  - dust belt of luminosity  $\sim 1000x$  solar
  - dust temperature  $\sim 1.5x$  vs. Kuiper Belt
  - planet host star; age  $\approx 3.2 \pm 1.2$  Gyr  
(Bonfanti et al. 2015)



# impact simulations

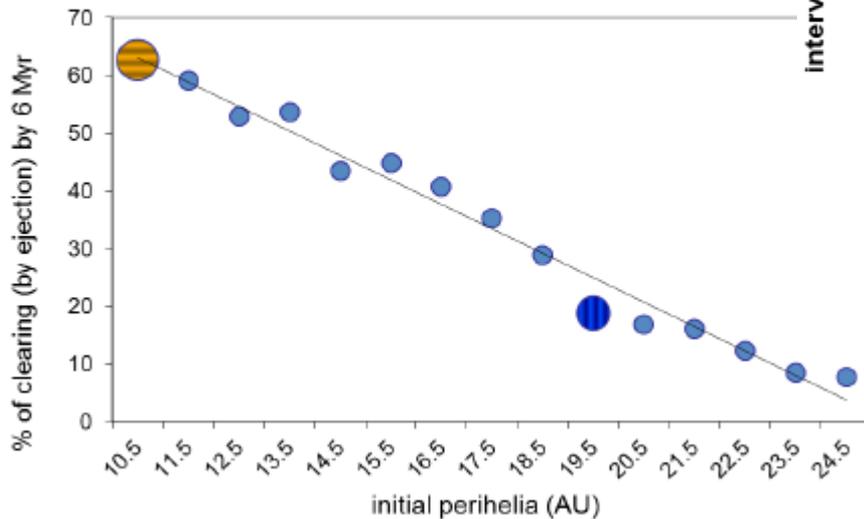


star hits & ejections beyond 1000 AU

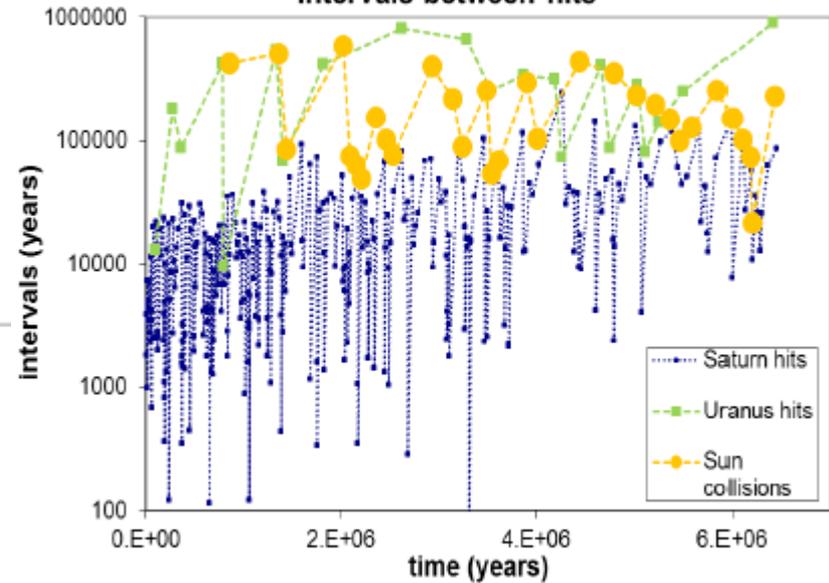


(Greaves, Jeffers & Horner, in prep.)

perihelia of ejected bodies

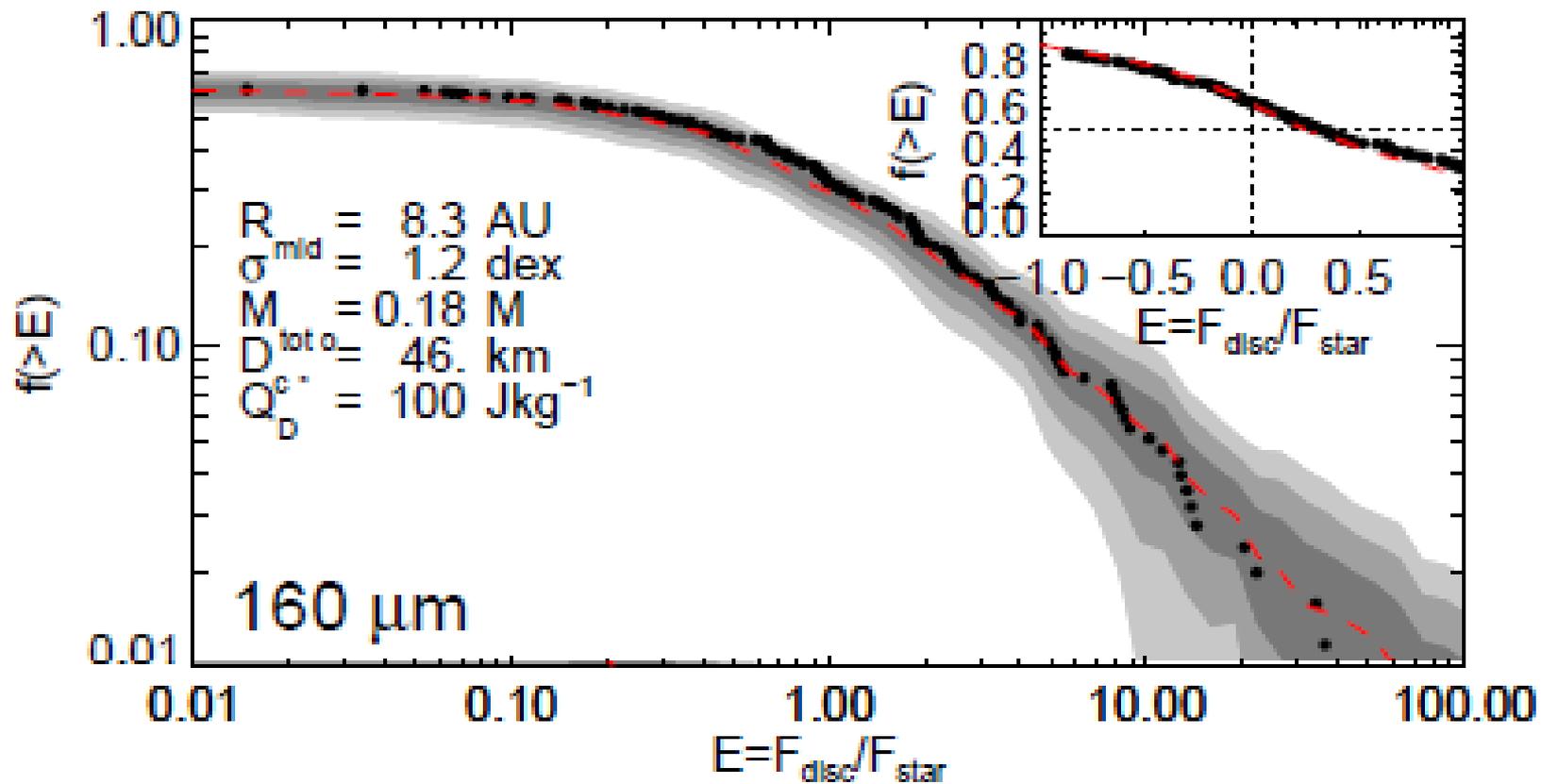


intervals between hits



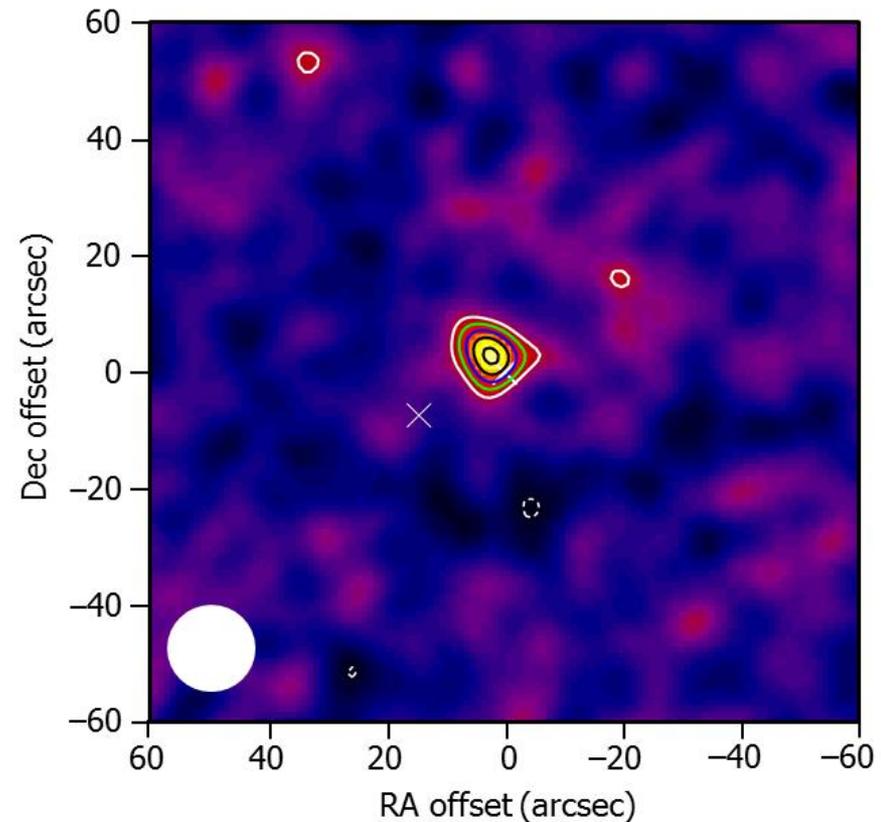
# debris around FGK stars

(Sibthorpe et al., in prep.)



# planets & comets at $\gg t_{\text{Sun}}$

- archetype is  $\tau$  Ceti
  - $t \approx 10$  Gyr
  - 3+ low-mass planets
  - has a comet belt with luminosity  $\gg$  the Sun's



# what is needed...?

- compare catalogues of debris discs and planets
- simulate impacts for a variety of systems
- critique the outcomes:
  - ... lava worlds?
  - ... watery worlds?
  - ... unstable surfaces &/or atmospheres?
  - ... warm basins?