Debris around Sun-like stars

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Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research (NWO)

What is a debris disc?

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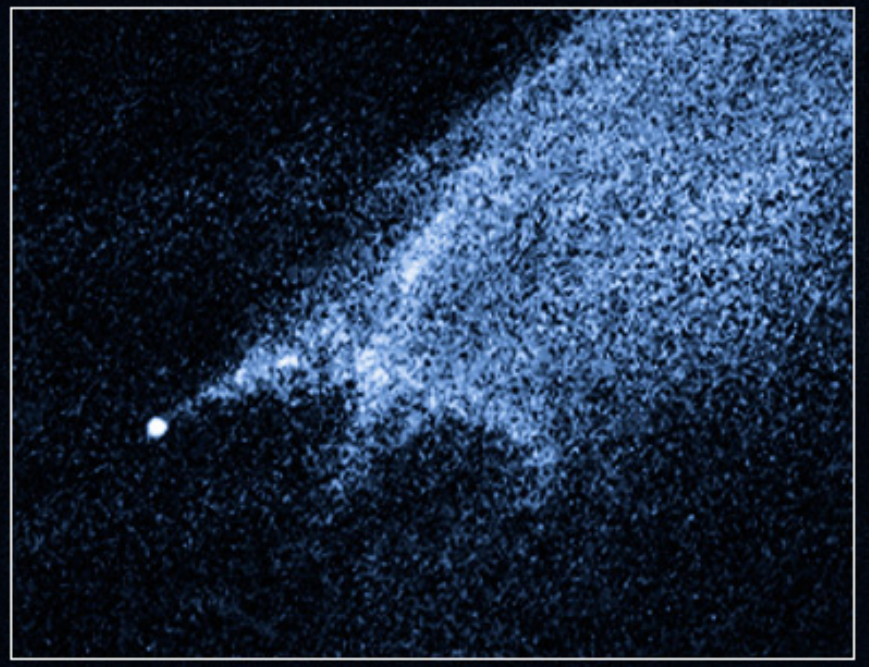
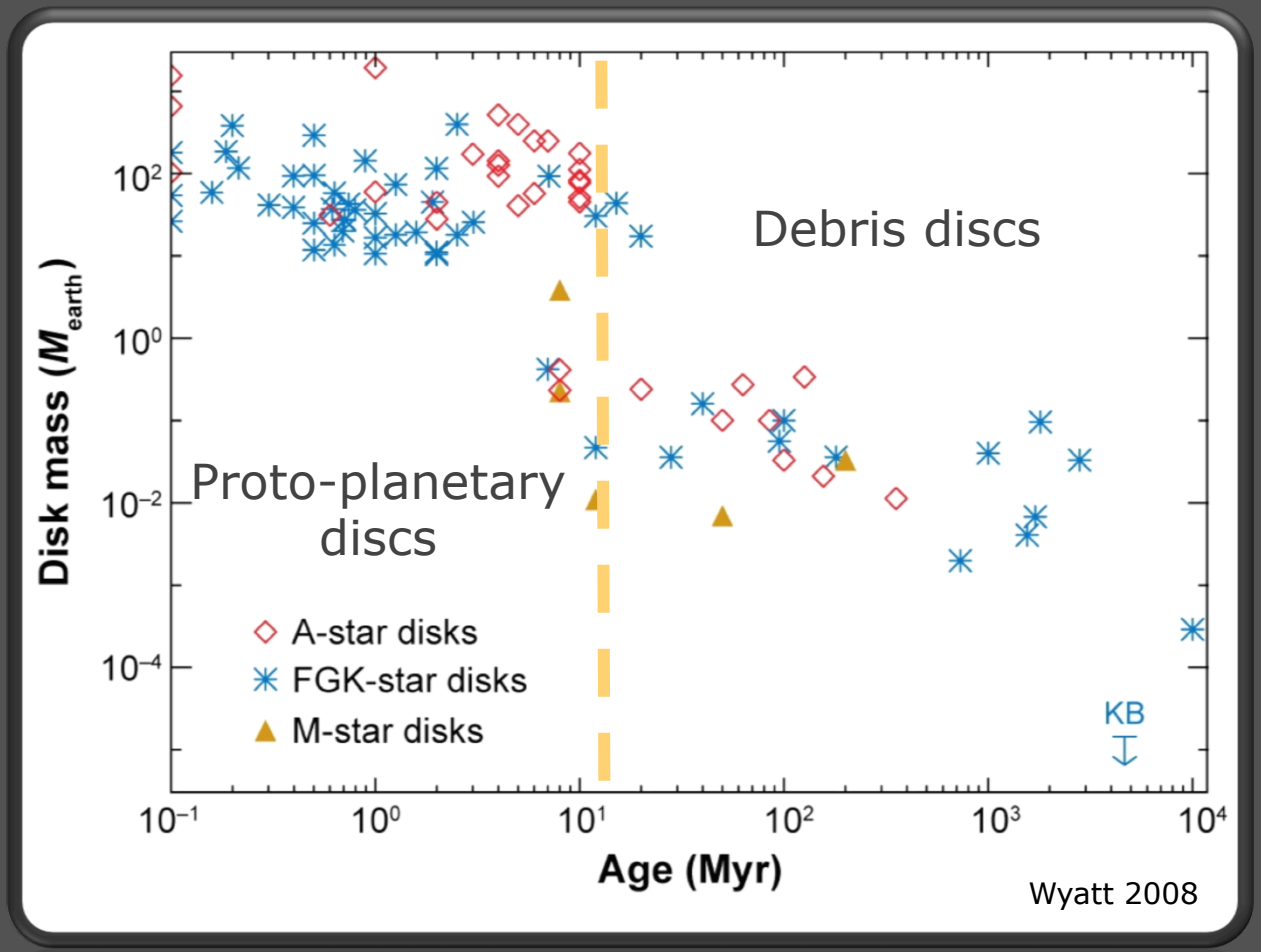


HST image of comet-like object P/2010 A2, first discovered by the LINEAR

Credit: NASA, ESA, and D. Jewitt (UCLA)

What is a debris disc?



Wyatt 2008

DEBRIS Survey

Disc **E**mission via a **B**ias-free **R**econnaissance in the **I**nfrared and **S**ubmillimetre)

- Primary science goals:
  - To establish what factors affect having a debris disc – planets, multiplicity, stellar mass etc
  - To place the solar system in context (common or unusual?)
  - To characterize the nearby debris disc population
  - To resolve discs and model their structure

- Survey design
  - Unbiased survey of 446 nearby stars
  - Flux limited photometric survey
  - All targets observed with PACS 100 and 160 μm
  - Follow-up of interesting sources with PACS at 70 μm, and SPIRE at 250, 350 and 500 μm

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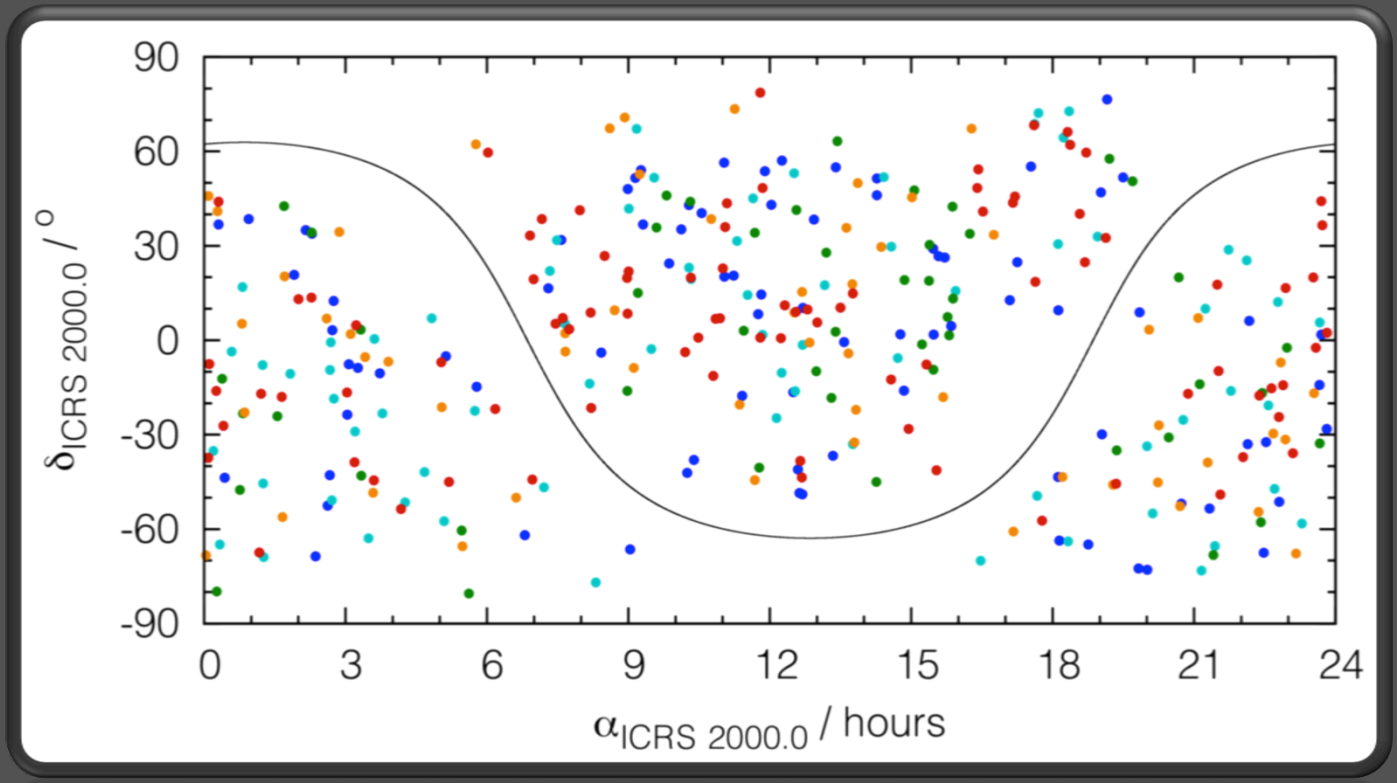
DEBRIS Survey: Targets

- Volume limited sample of the closest ~90 stars in each spectral type A-M (Phillips et al. 2010)
  - Volume limits: 46, 24, 21, 16 8.6 pc (A-M) with applied 1.2 mJy 100 μm cirrus confusion cut



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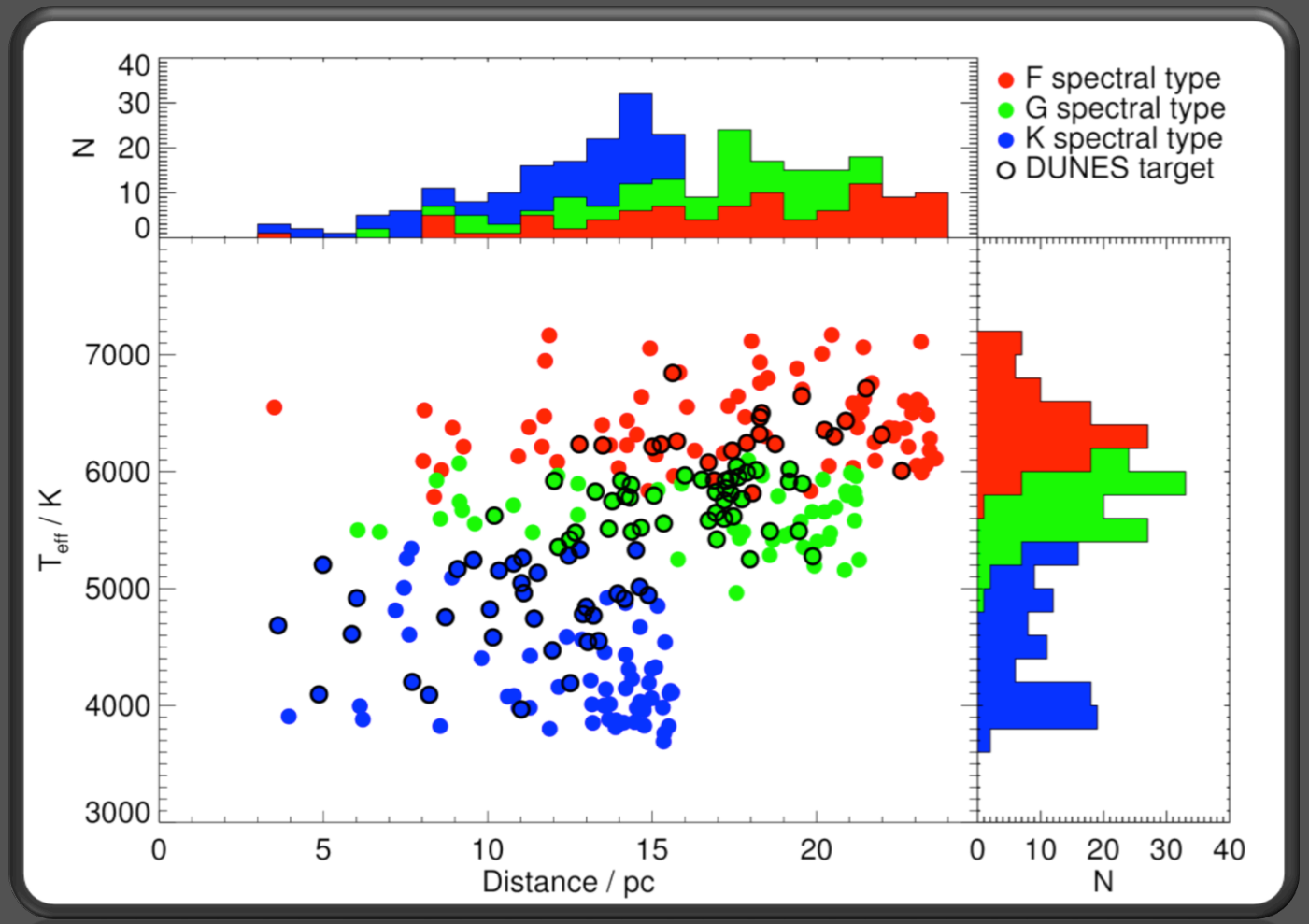
DEBRIS Survey: Targets



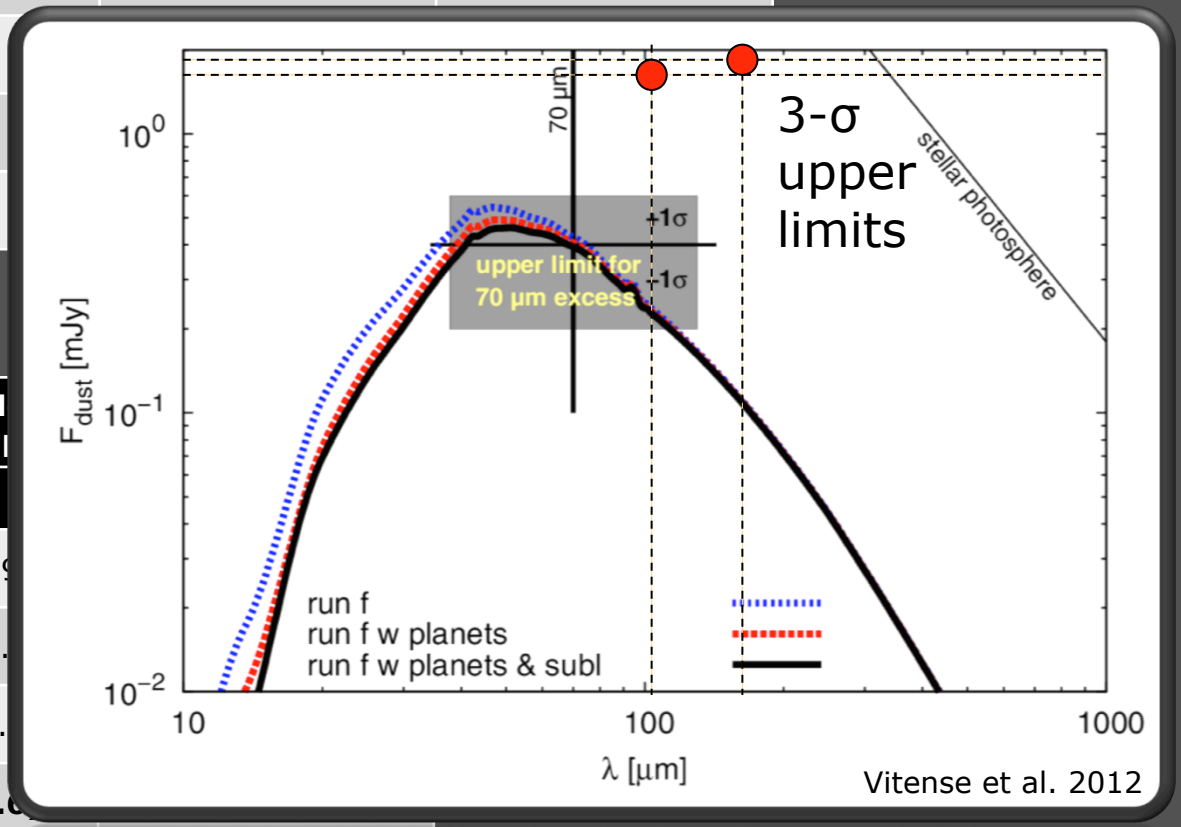
Results

Detections and incidence rates

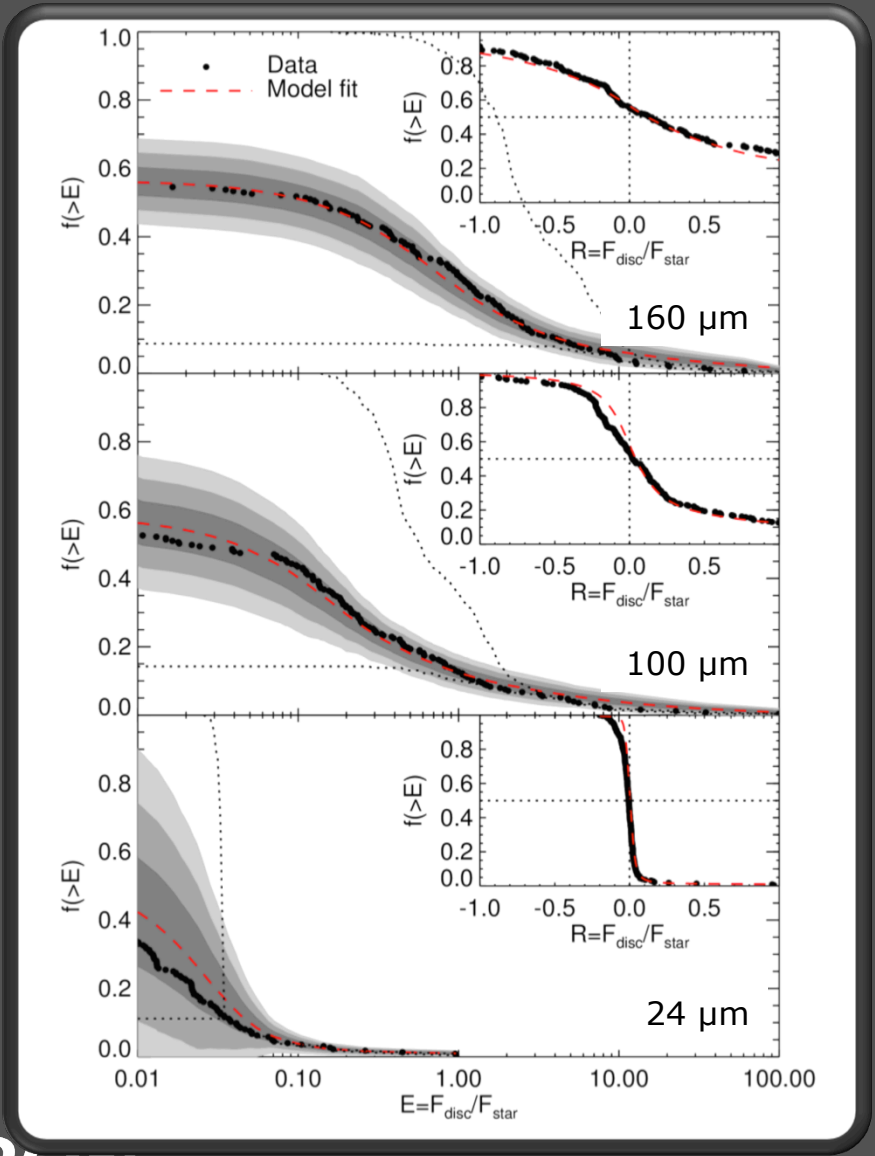
Spectral type	No. observed	No. discs detected	Incidence rate %
F	94	24	26±5.2
G	88		
K	91		
F, G, K	**273**		

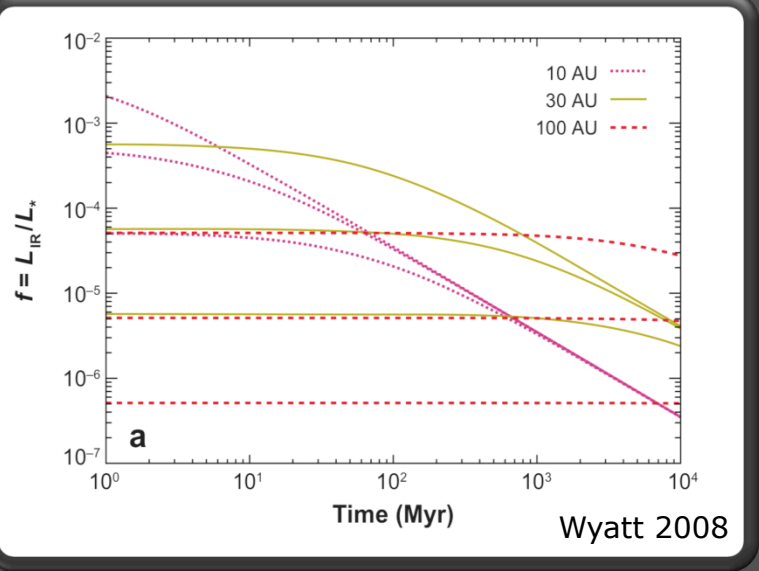
Stacking

Spectral type	M (3σ u
	100 μm
F	2.4±1.2 (5.9
G	0.03±0.3 (0.
K	-0.5±0.3 (0.
F, G, K	**0.4±0.4 (1.**



Population modeling





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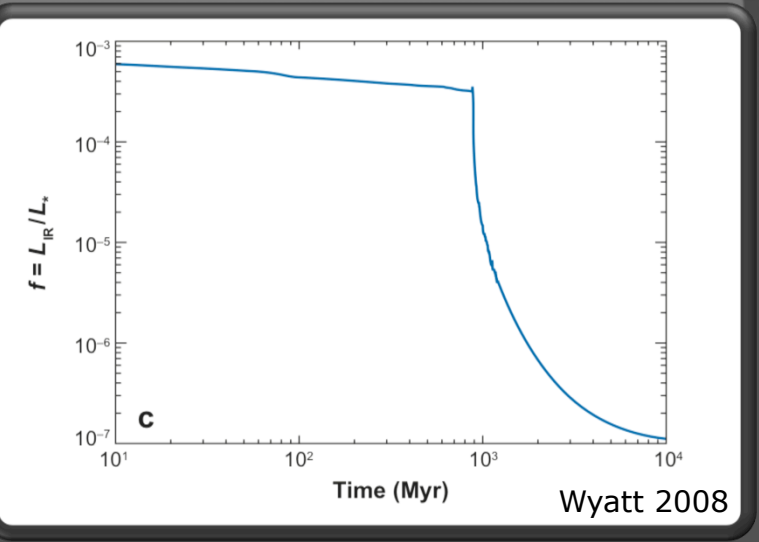
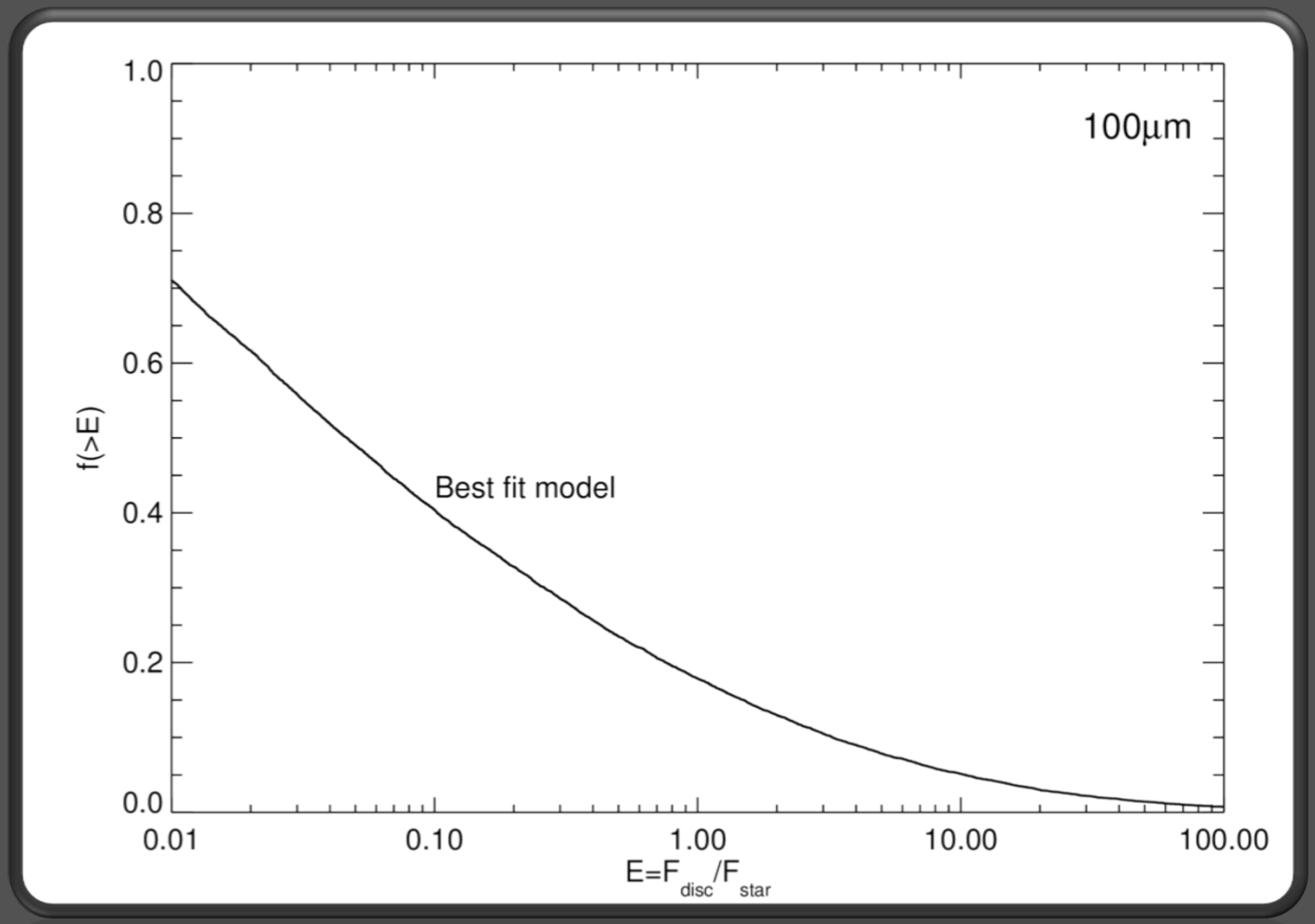


Wyatt 2008

Population modeling



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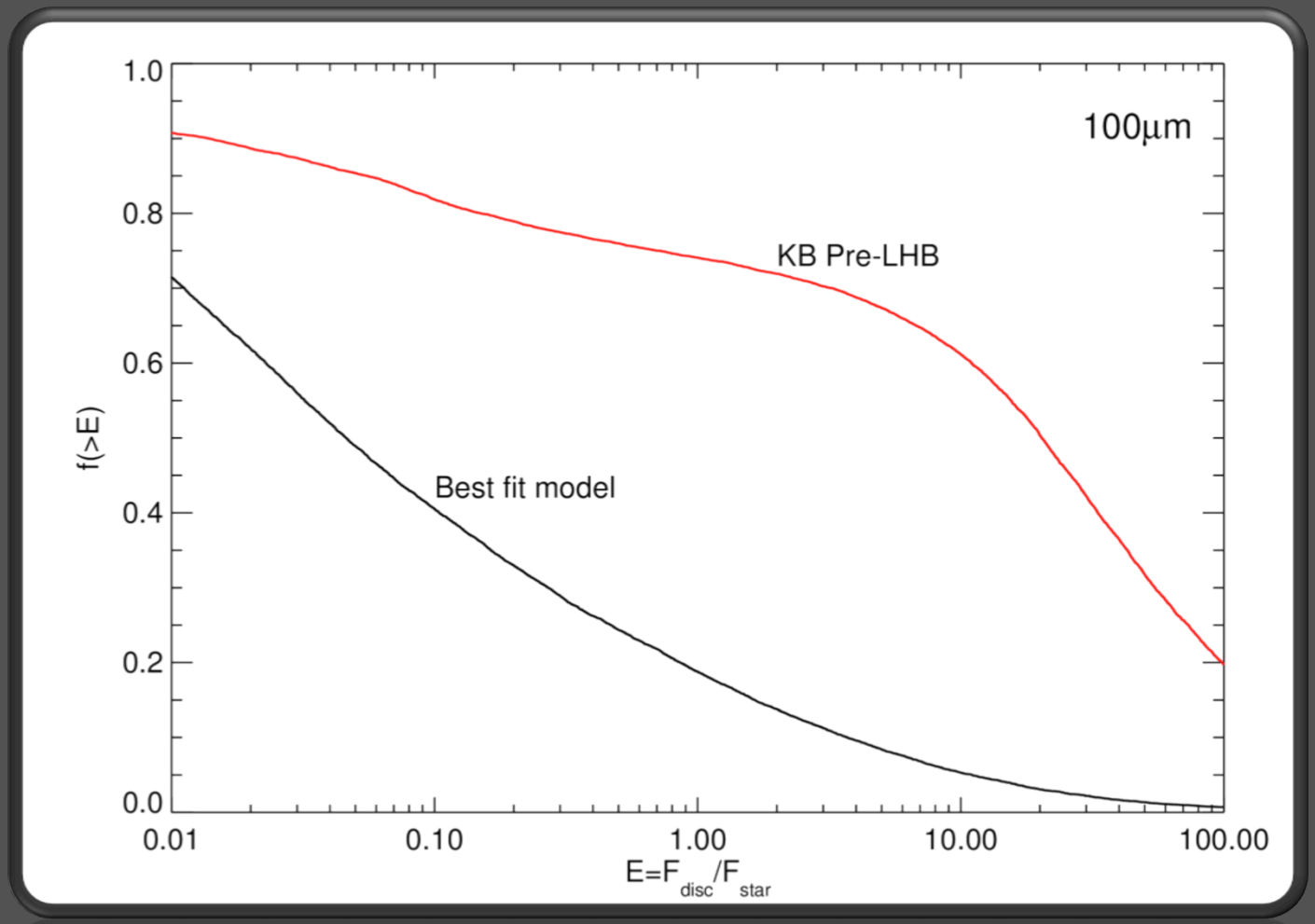

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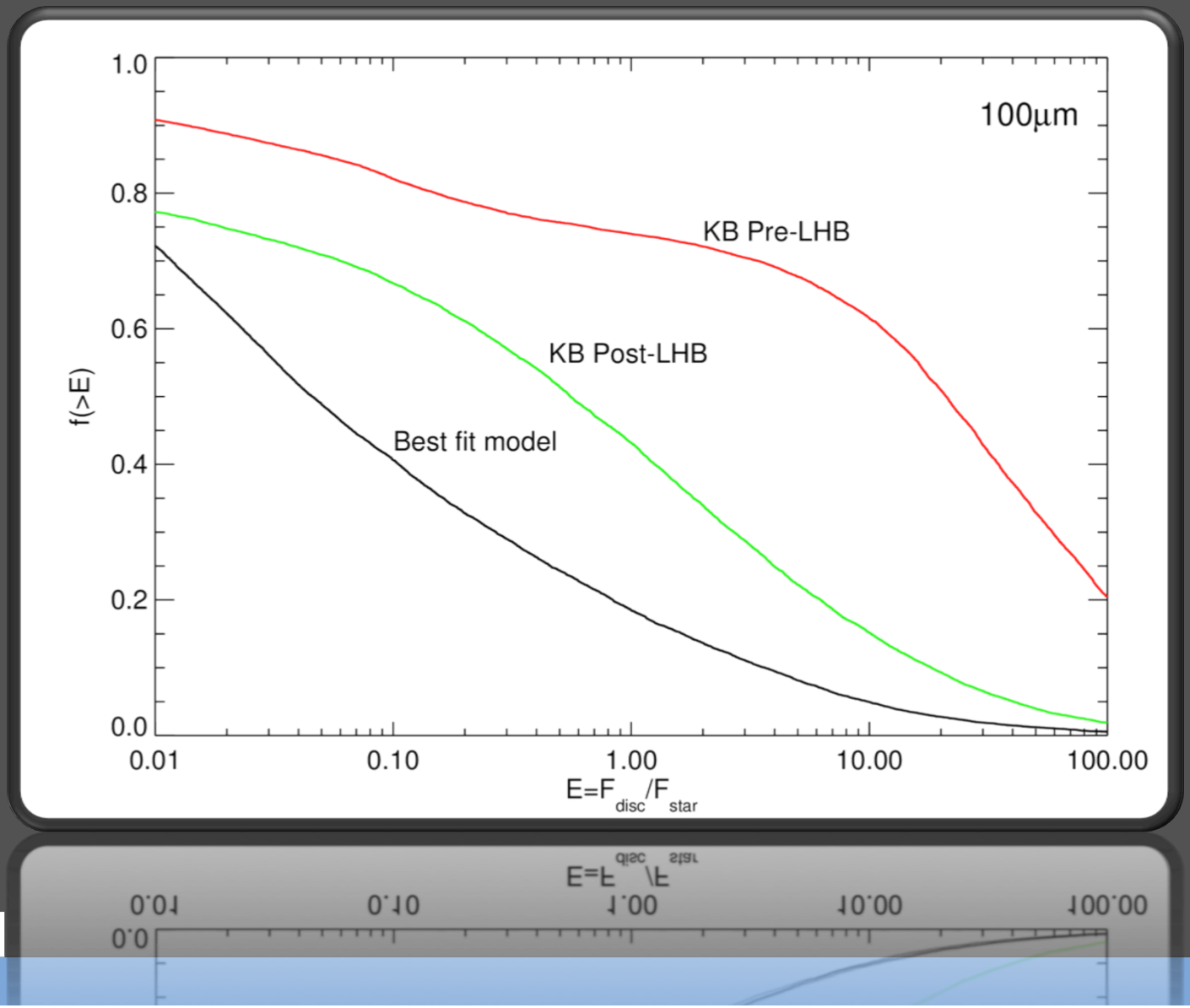
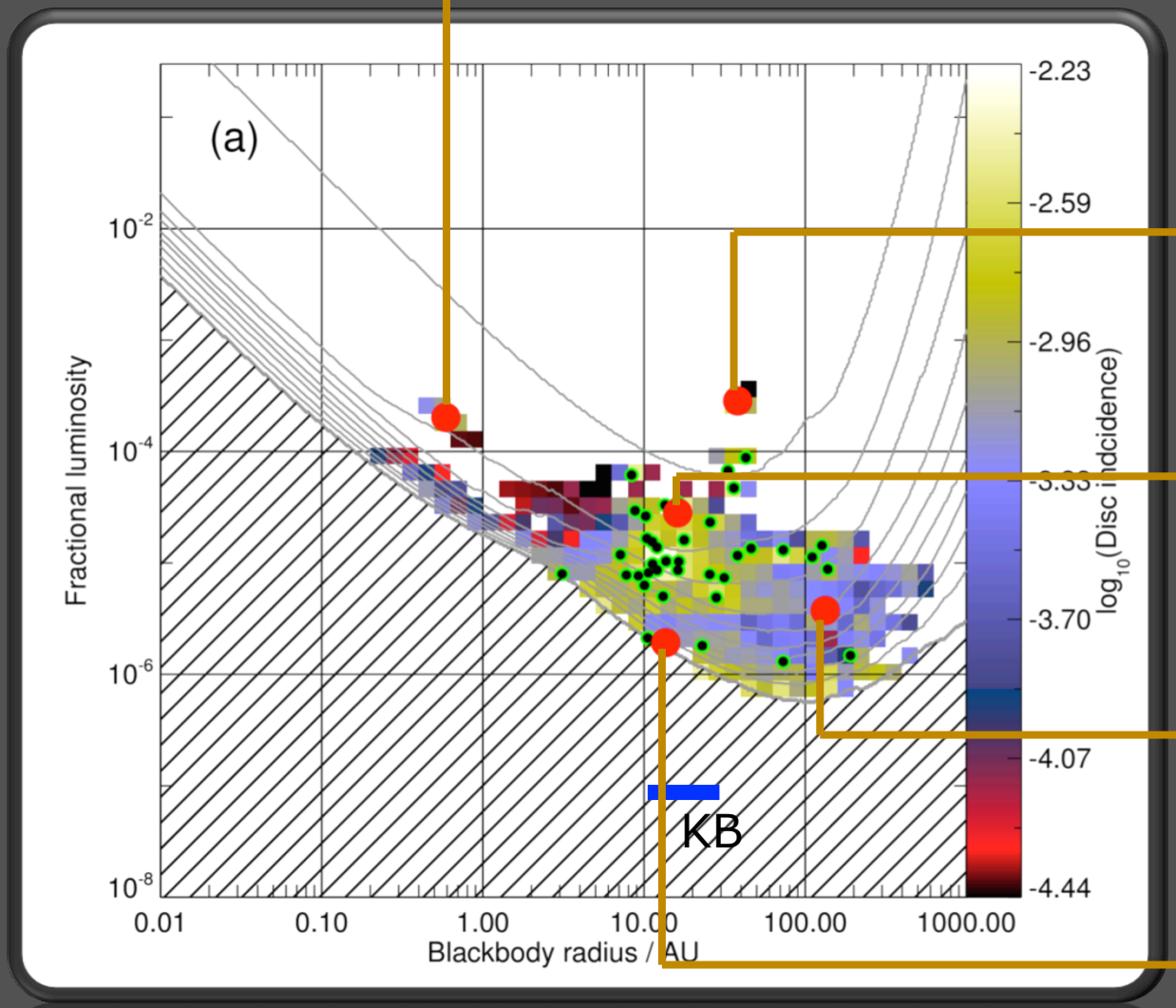
Population modeling



Disc radius vs. fractional luminosity



HD69830
- 6 Gyr
- 3 low mass planets (<0.6 AU)

q^1 Eri
- 7 Gyr
- 1 high mass planet (~2 AU)

61 Vir
- 5 Gyr
- 3 low mass planets (<0.5 AU)

HD 19994
- 4 Gyr
- 1 high mass planets (<0.5 AU)

HD 20794
- 6 Gyr
- 3 low mass planets (<0.35 AU)

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Completeness corrected incidence

Spectral Type	No. observed	No. discs detected	Incidence rate %	Incidence rate (adjusted for completeness) %
F	94	24	26±5.2	40±6.6
G	88	11	13±3.8	23±5.1
K	91	10	11±3.5	17±4.3
F, G, K	**273**	**45**	**16±2.5**	**25±3.1**

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Summary

- Debris disc incidence for FGK stars
  - Measured ~16% - in-keeping with previous measurements
  - Completeness corrected ~25%
- Stacking: searching for faint debris
  - Kuiper belt still too faint to be observed with *Herschel*
  - Detected median excess at 100 and 160 μm consistent with zero
- Model fitting
  - Disc population can be fit with a simple steady-state evolution
  - Best fit is achieved when model disc radii are between ~2-300 AU, and have initial disc masses of ~1.5 M_{earth}
- Characterisation of disc population
  - Typical disc blackbody radius ~10 AU
  - The Kuiper belt is a typical radius for a debris disc
  - Systems containing both debris and planets exhibit atypical disc properties - at ages similar to that of the Solar-system
- Solar-system in context – i.e. the bigger picture
  - Not all systems follow the evolutionary path of the KB, either steady-state or post LHB

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