



Linking stars, planets and debris through Herschel observations of radial velocity exoplanet host stars

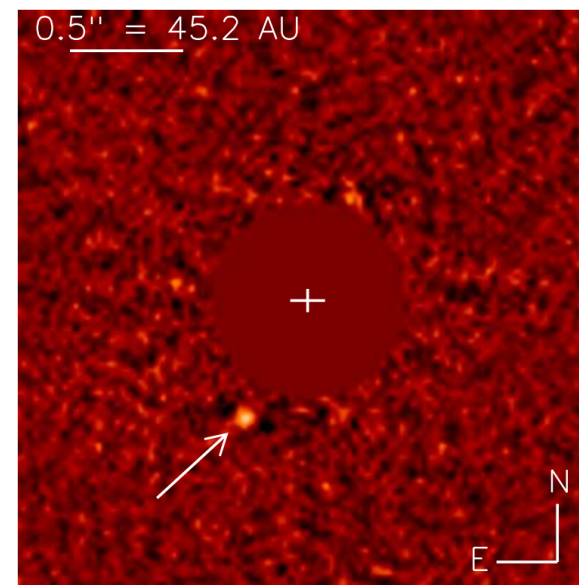
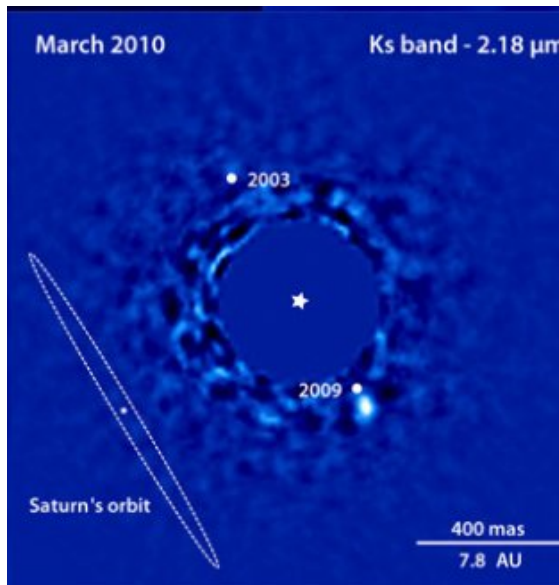
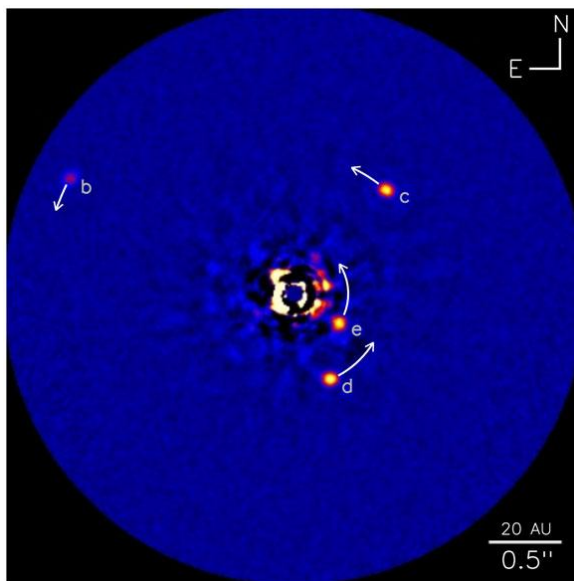
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Introduction

- Herschel observed 104 radial velocity exoplanet host stars, of which 30 also had detectable circumstellar discs (DEBRIS, DUNES, GT and SKARPS)
- Given that we expect planets to form from the agglomeration of planetesimals, there should be some link between the two
- Previous work with Spitzer identified no correlation between planets and debris (Moro-martin et al. 2007, Bryden et al. 2009)
- Observational signatures of planets may be visible in the spatial distribution of dust discs around other stars

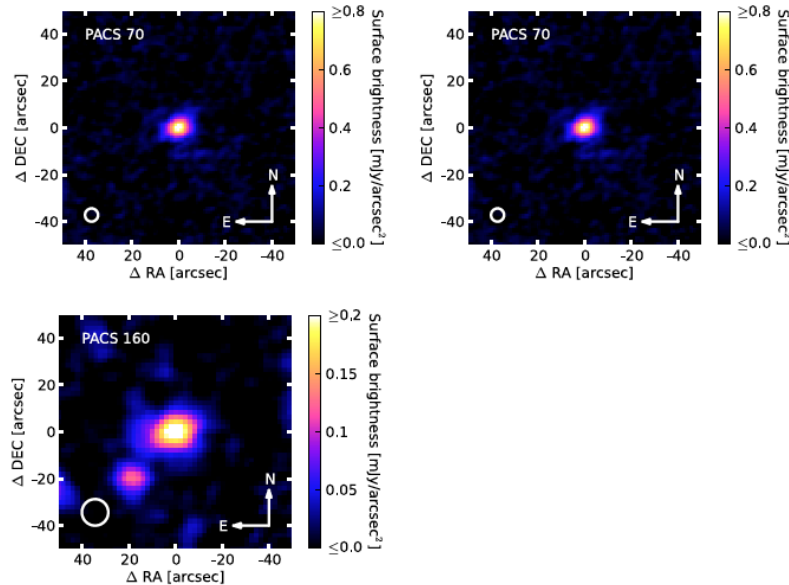
Imaging exoplanets

- We find exoplanets in systems with debris discs (Marois et al. 2008; Bonnefoy et al. 2011; Rameau et al. 2013)

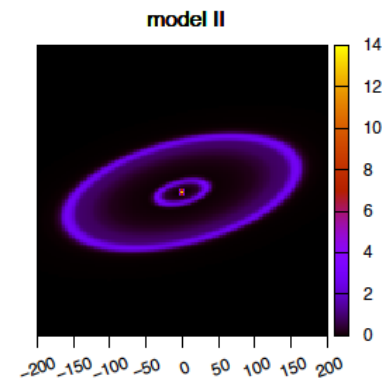
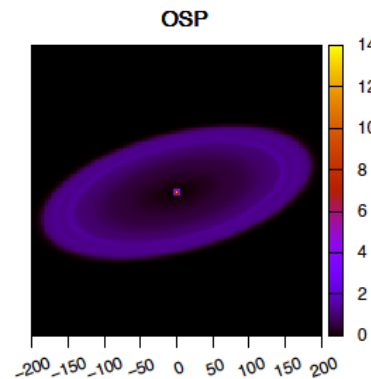
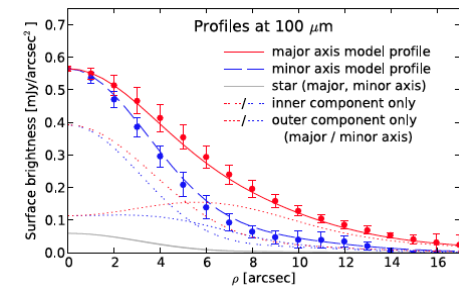
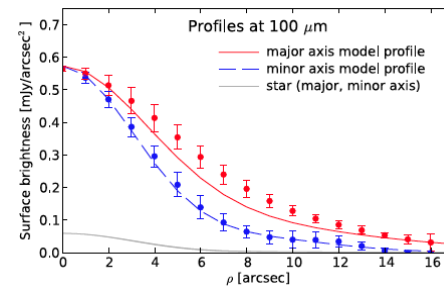
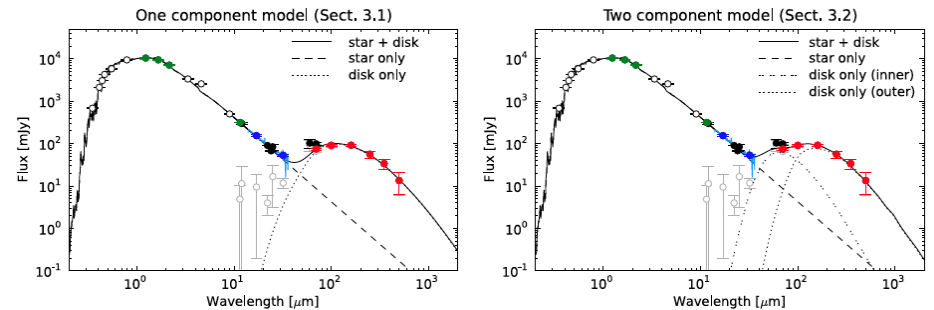


Multi-component discs

- HIP 17439's debris disc is potentially the result of two cold dust belts

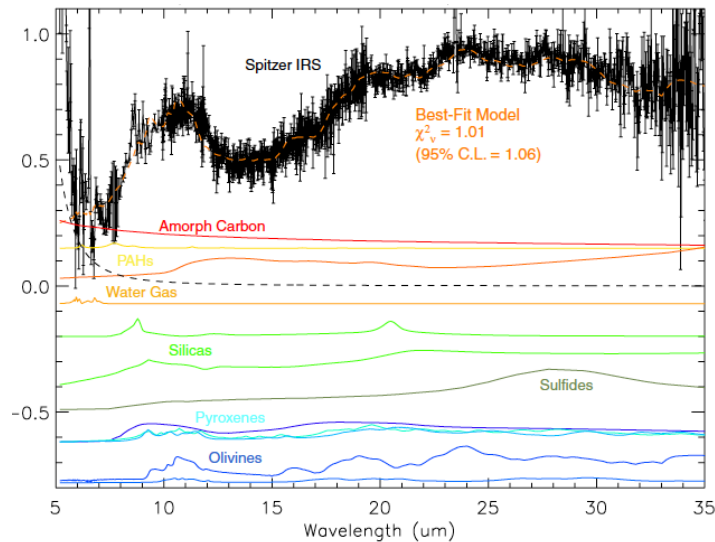


Ertel et al. 2014
Schueppler et al., subm.

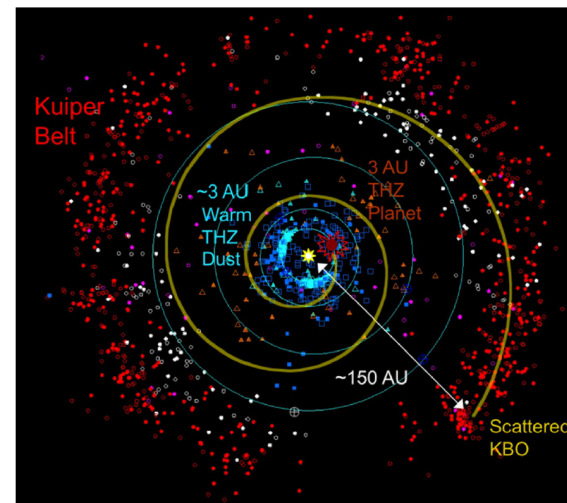
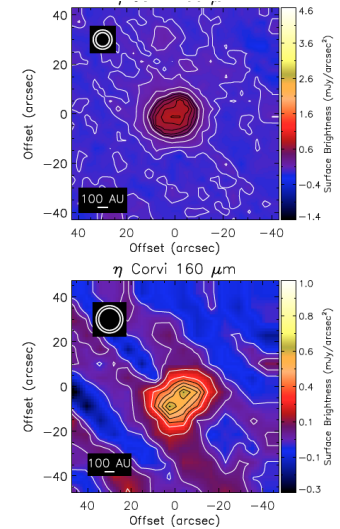
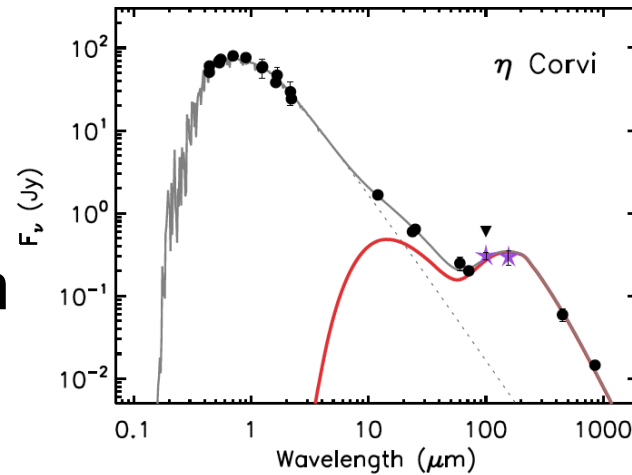


Dynamical interactions

- e.g. Eta Corvi's Spitzer IRS spectrum shows evidence for KBO material in inner system

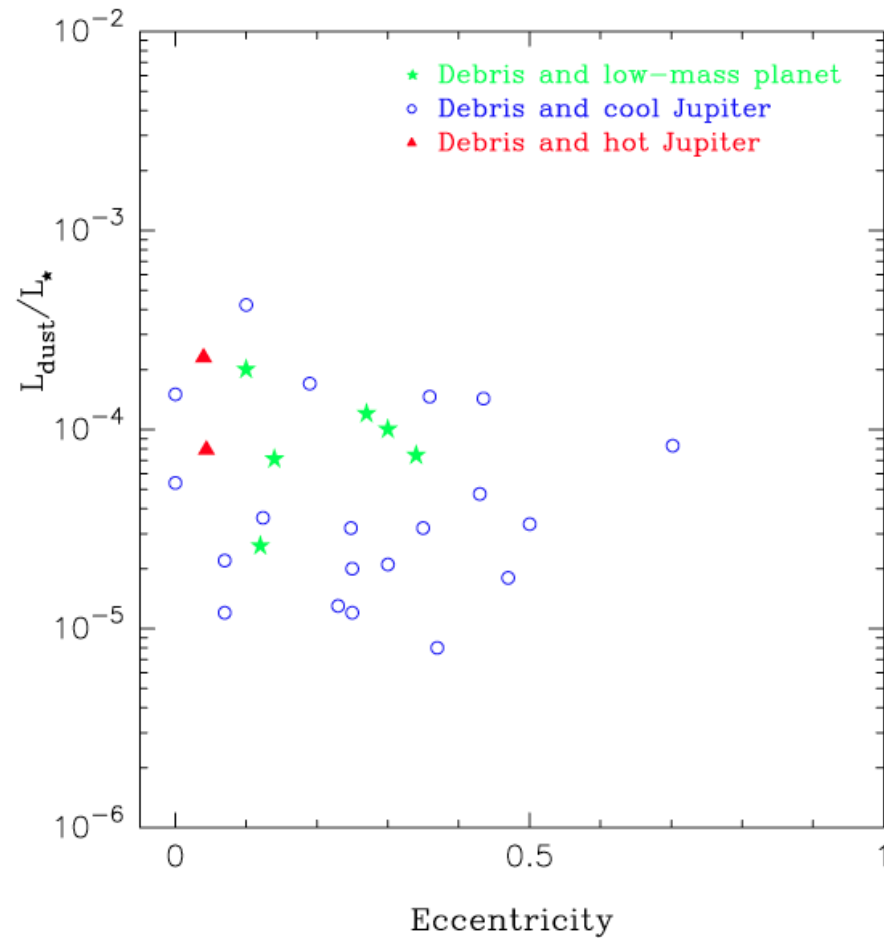


Matthews et al. 2010
Lisse et al. 2012



Perturbation

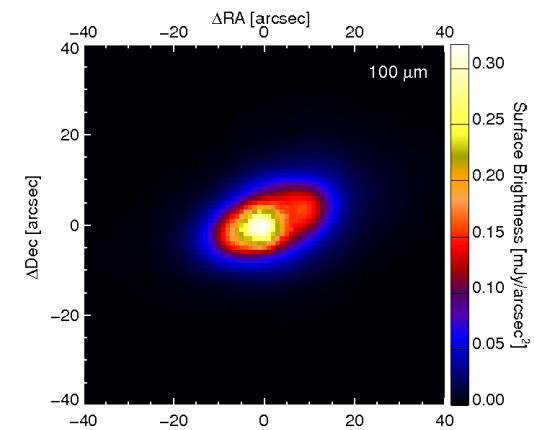
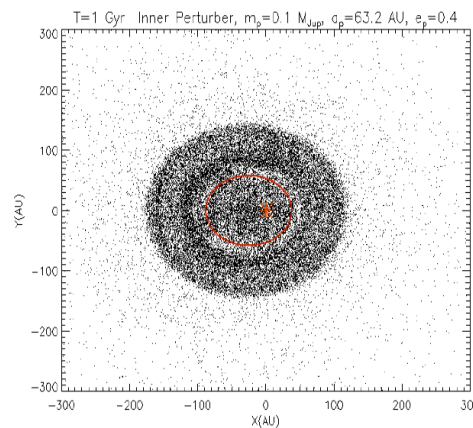
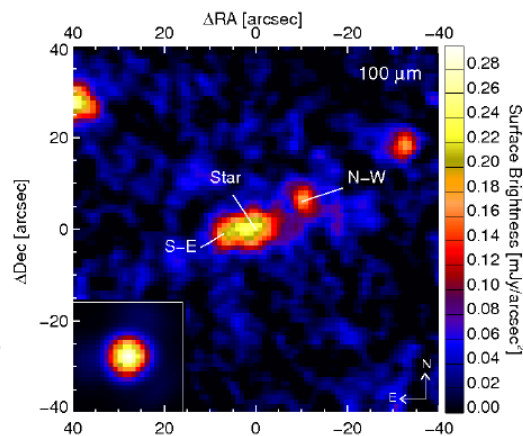
- Stars hosting exoplanets with low orbital eccentricities show a weak tendency to have brighter discs
- Planets with lower e_{orb} are less disruptive to parent bodies in debris belts



Maldonado et al. 2012

Eccentric discs

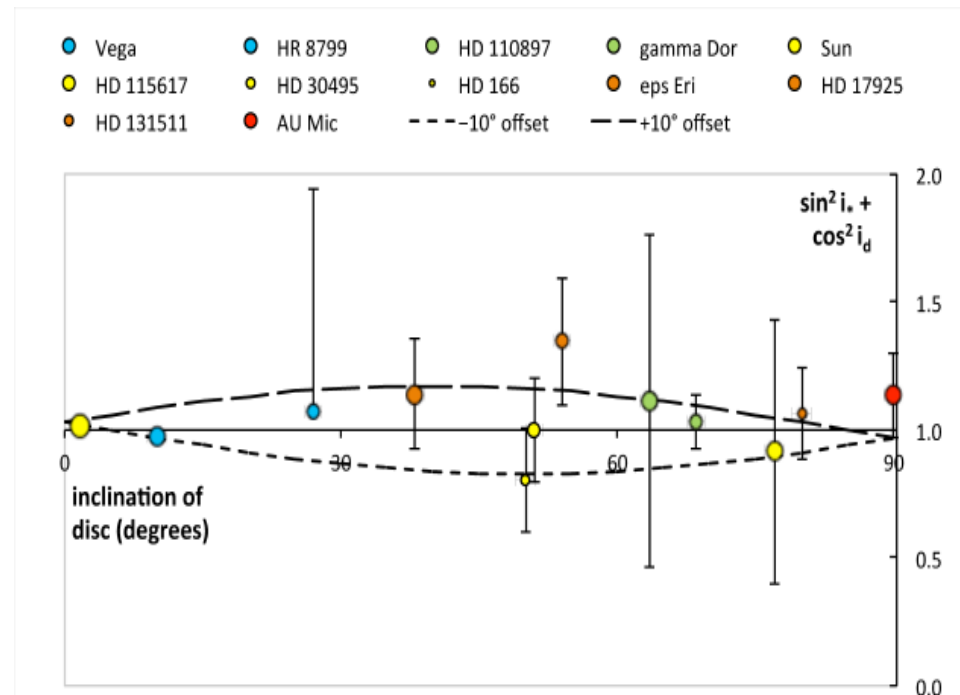
- e.g. HIP 15371
 - Asymmetric structure proposed to be the result of dynamical perturbation by a planetary companion
 - Similar evidence seen in other discs (in sub-mm) tends to be weak, potentially result of low s/n observation
 - Not necessarily a planet, as remnant gas could affect dust



Faramaz et al. 2014

Coplanarity

- Inclination of star, i_* , and disc, i_d
- Debris discs are generally seen to lie along the equatorial plane of the host star
- Few exceptions, e.g. 99 Her (Kennedy et al. 2012)
- What about star-planet misalignment?

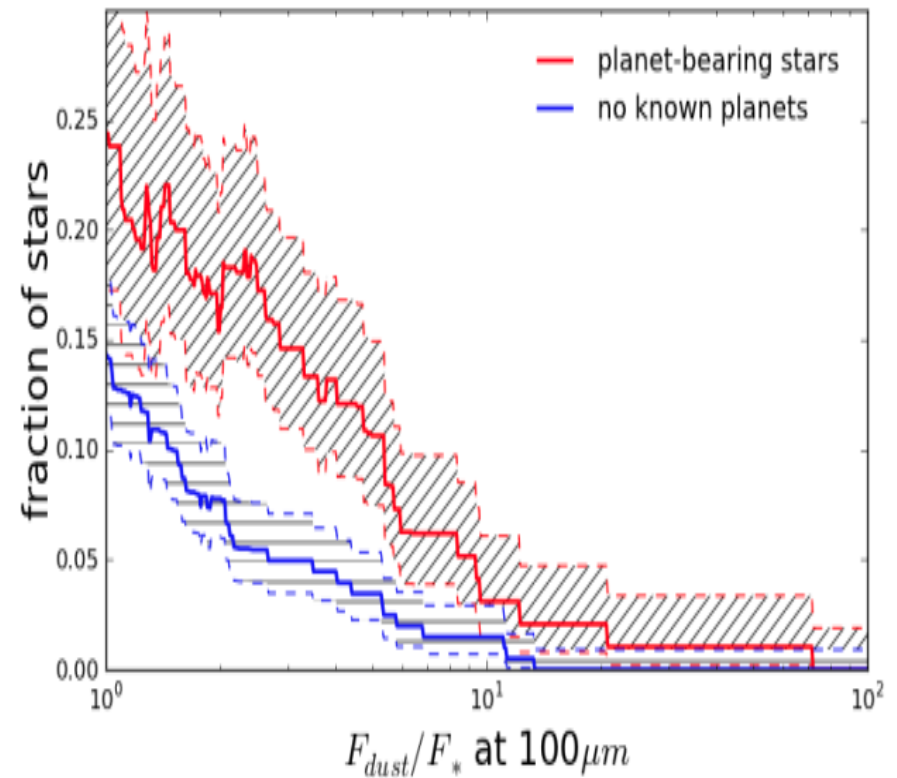


Greaves et al. 2013

Watson et al. 2011

Debris and planets

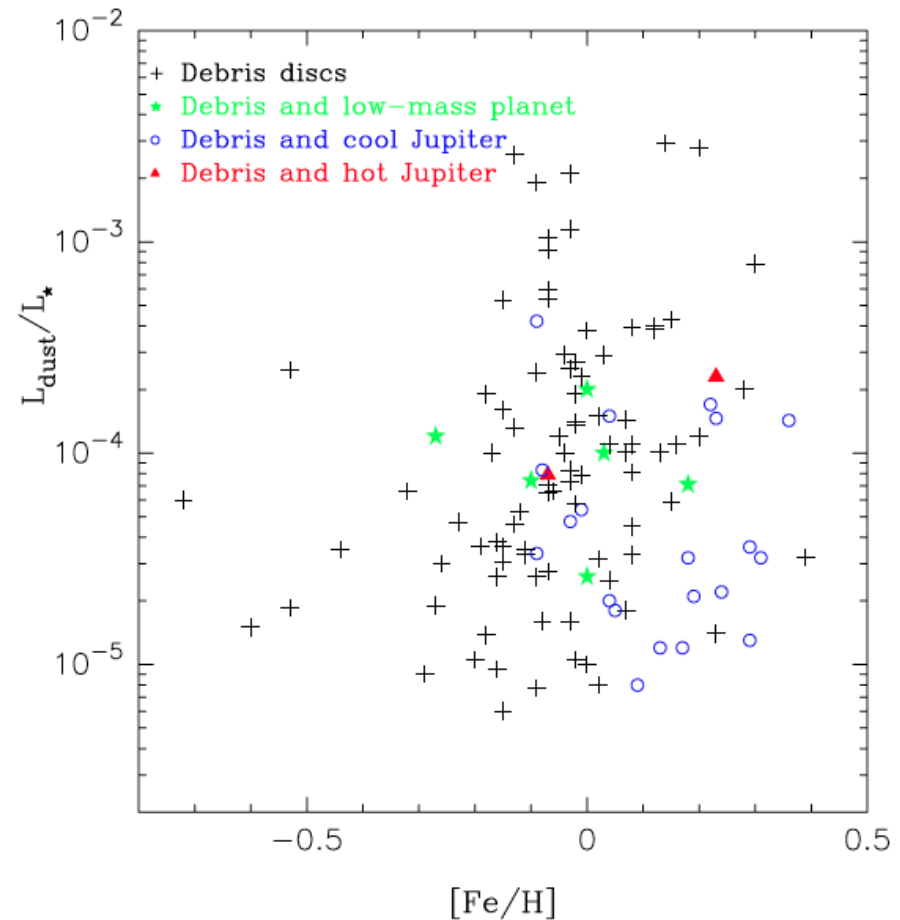
- Incidence of debris is correlated with the presence of exoplanets
- Planet-bearing stars: $28/99 = 28 \pm 5\%$ with disks
- No known planets: $43/203 = 21 \pm 3\%$ with disks



Bryden et al. 2013

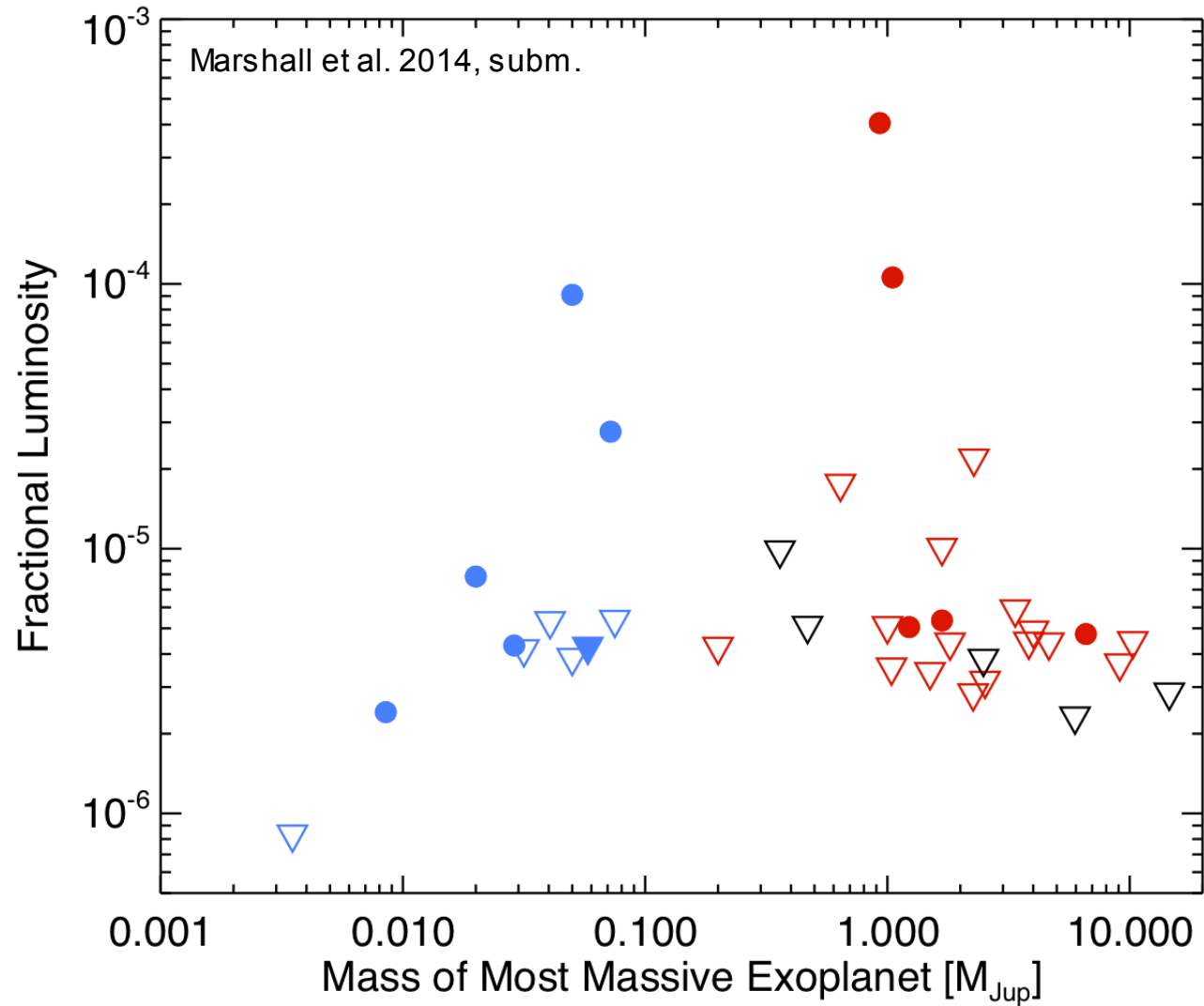
Debris and high mass planets

- No trend between $[\text{Fe}/\text{H}]$ and debris
- Higher $[\text{Fe}/\text{H}]$ stars are more likely to host Jovian planets
- Stars with cool Jupiters and discs have fainter discs

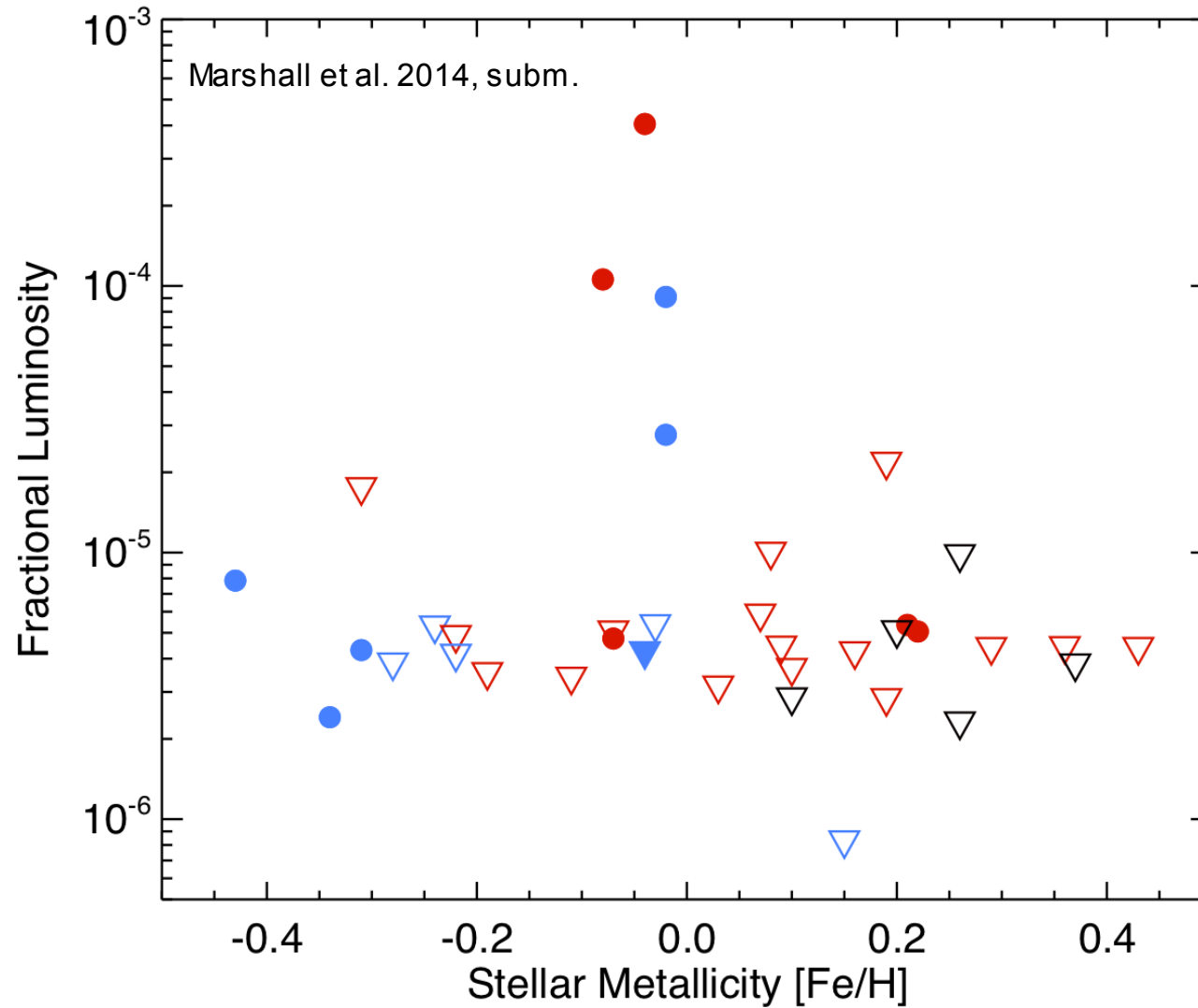


Maldonado et al. 2012

Debris and low mass planets



Debris and metallicity



Summary

- Look around stars with debris discs!
- Planets should lie in the plane of the system, which can be identified from the debris belt
- Tend to find low(er) mass planets around low metallicity stars, and therefore more dust
- ELT will characterise the warm dust emission, resolving these inner belts, and exoplanet properties through direct imaging and spectroscopy