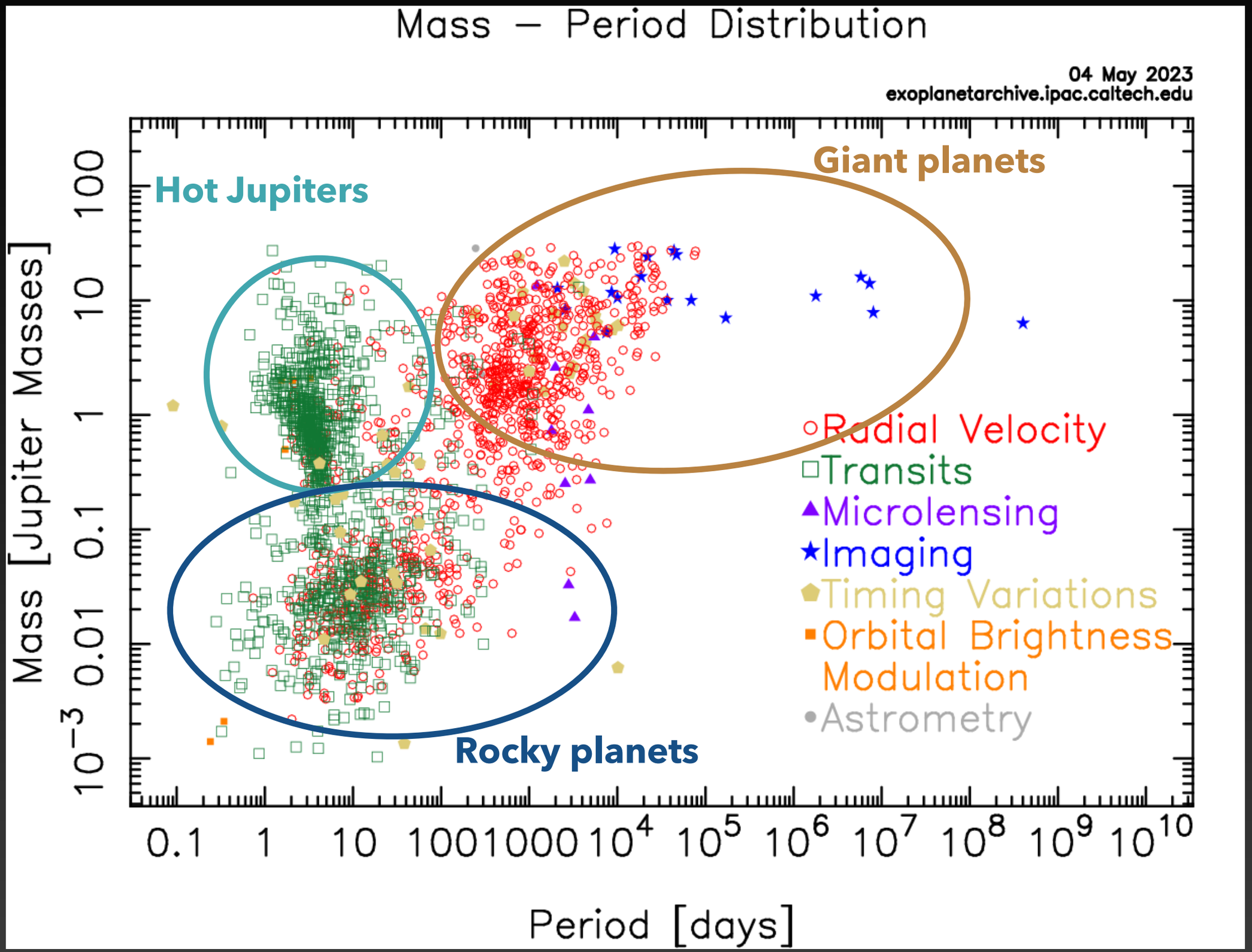
S01 Exoplanet host stars

R. Ligi, *T. Boyajian, A. Chiavassa, A. Gallenne, R. M. Roettenbacher, D. Mourard, R. Szabò, M. Wittkowski, T. Guillot, A. Crida, S. Albrecht, S. Borgniet*

ISSP Meeting - Nice, May 2023

Scientific objectives

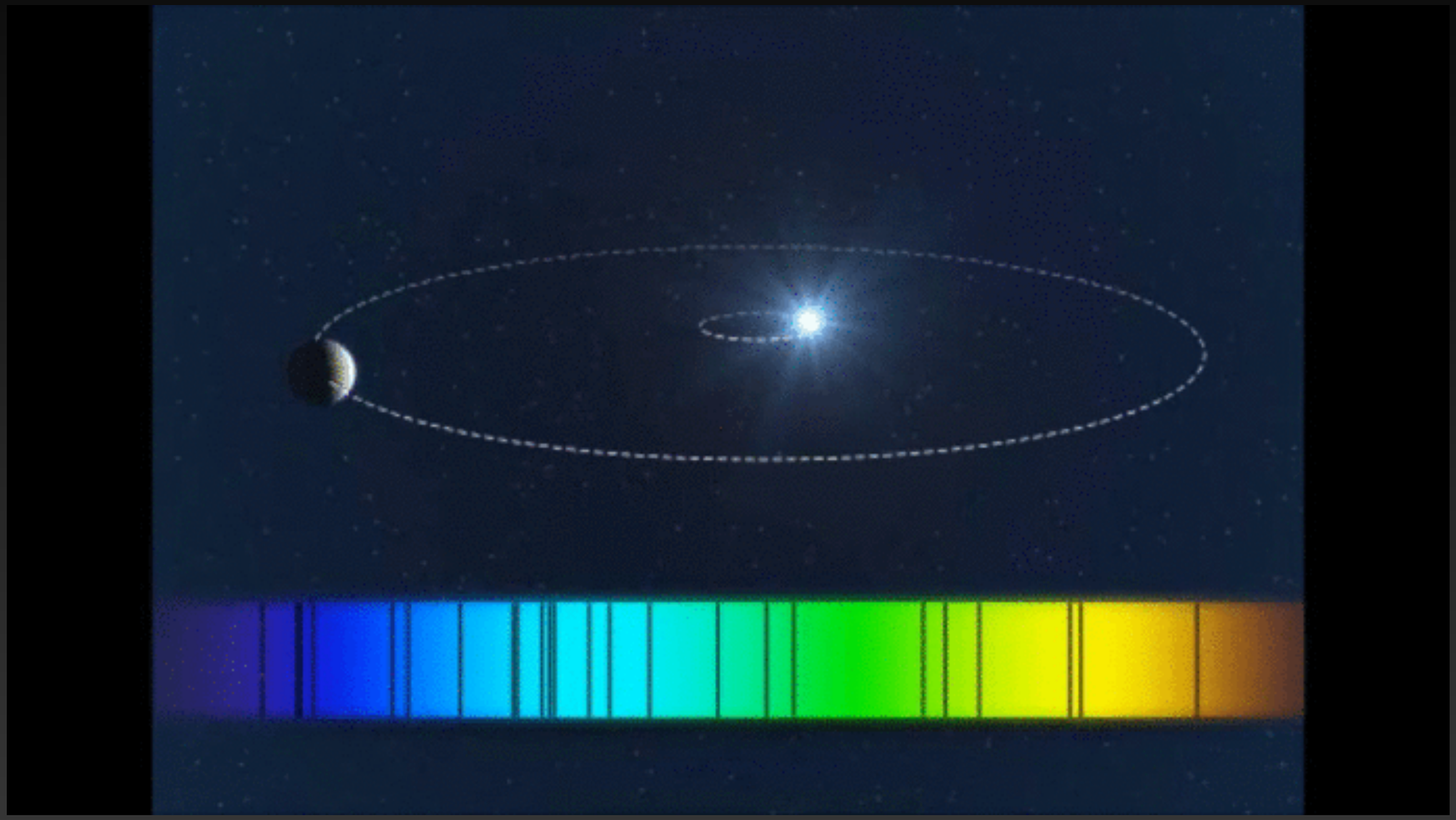
The characterisation of exoplanetary systems



Scientific objectives

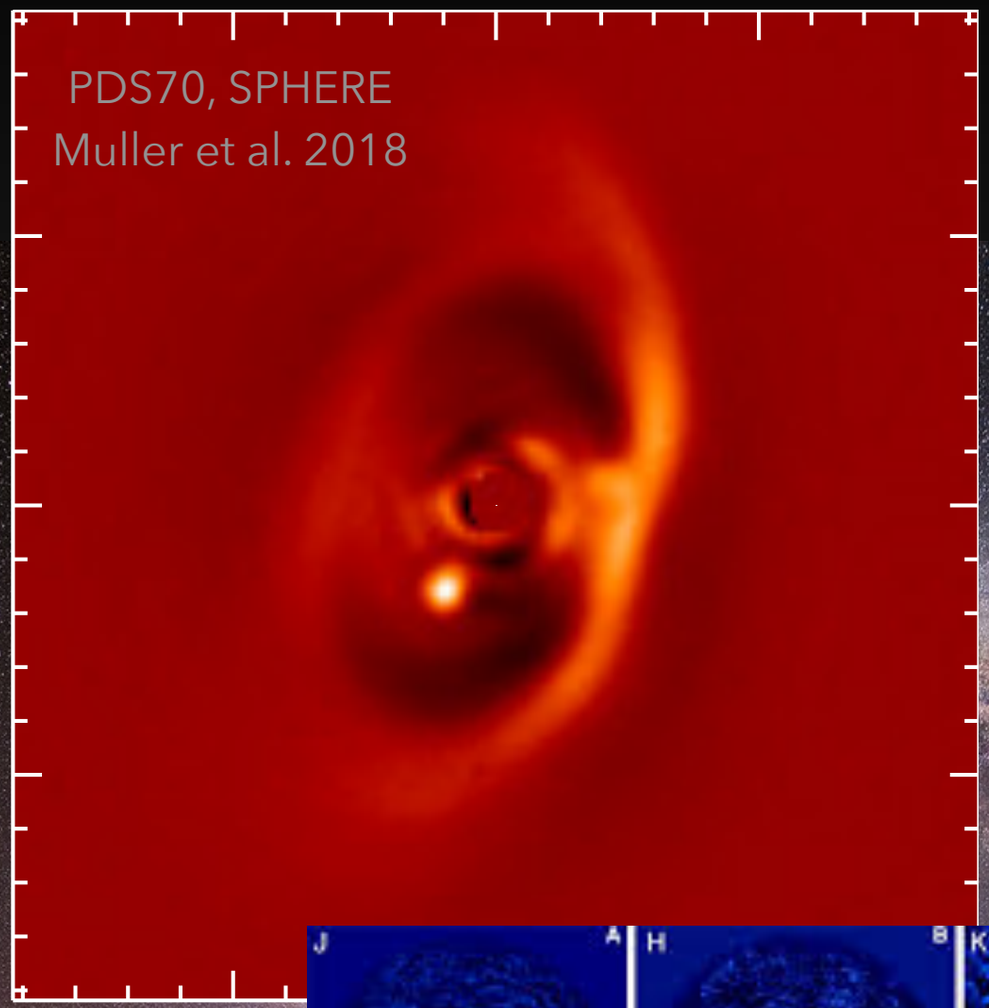
The characterisation of exoplanetary systems

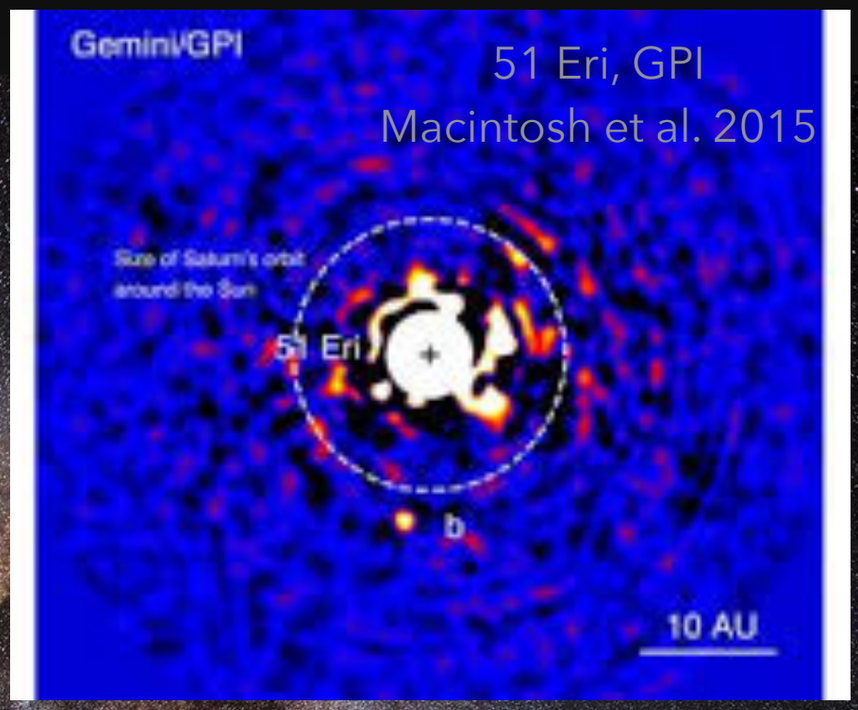
$V \propto M_p/M_\star$

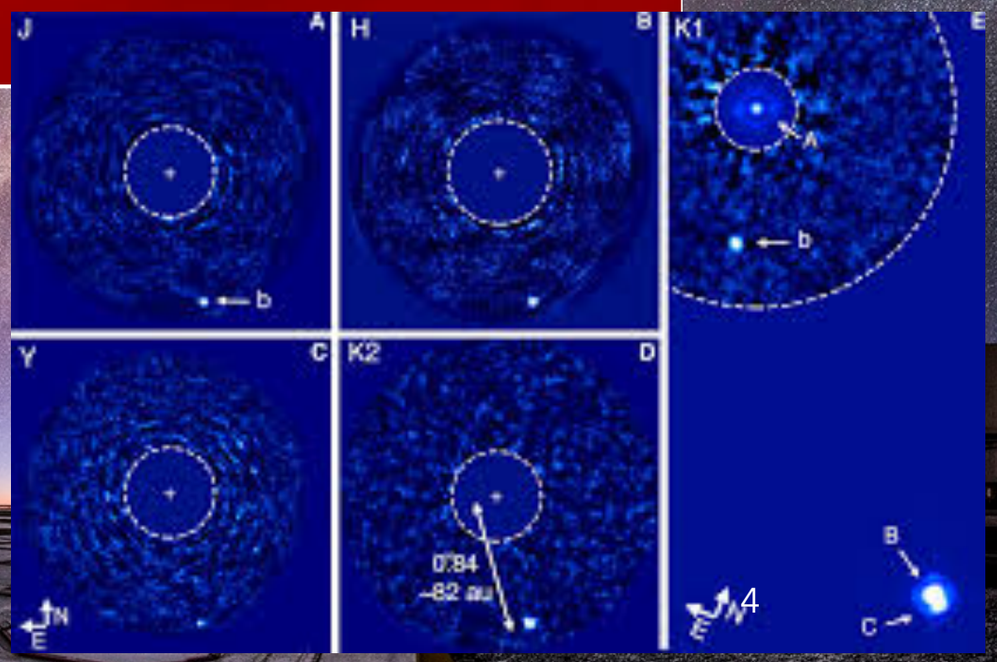


Scientific objectives

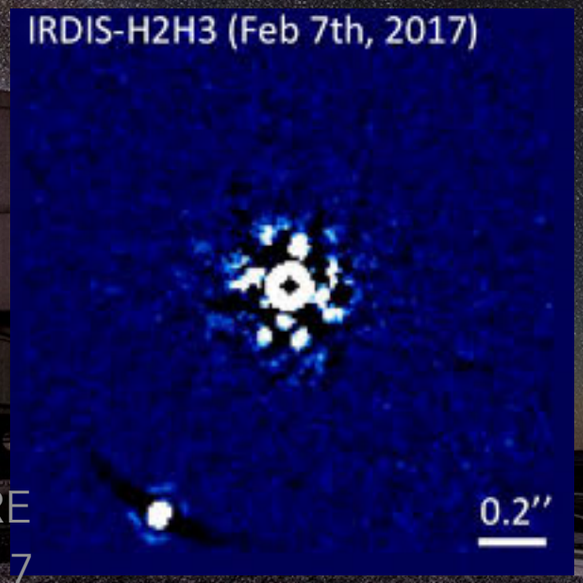
The characterisation of exoplanetary systems







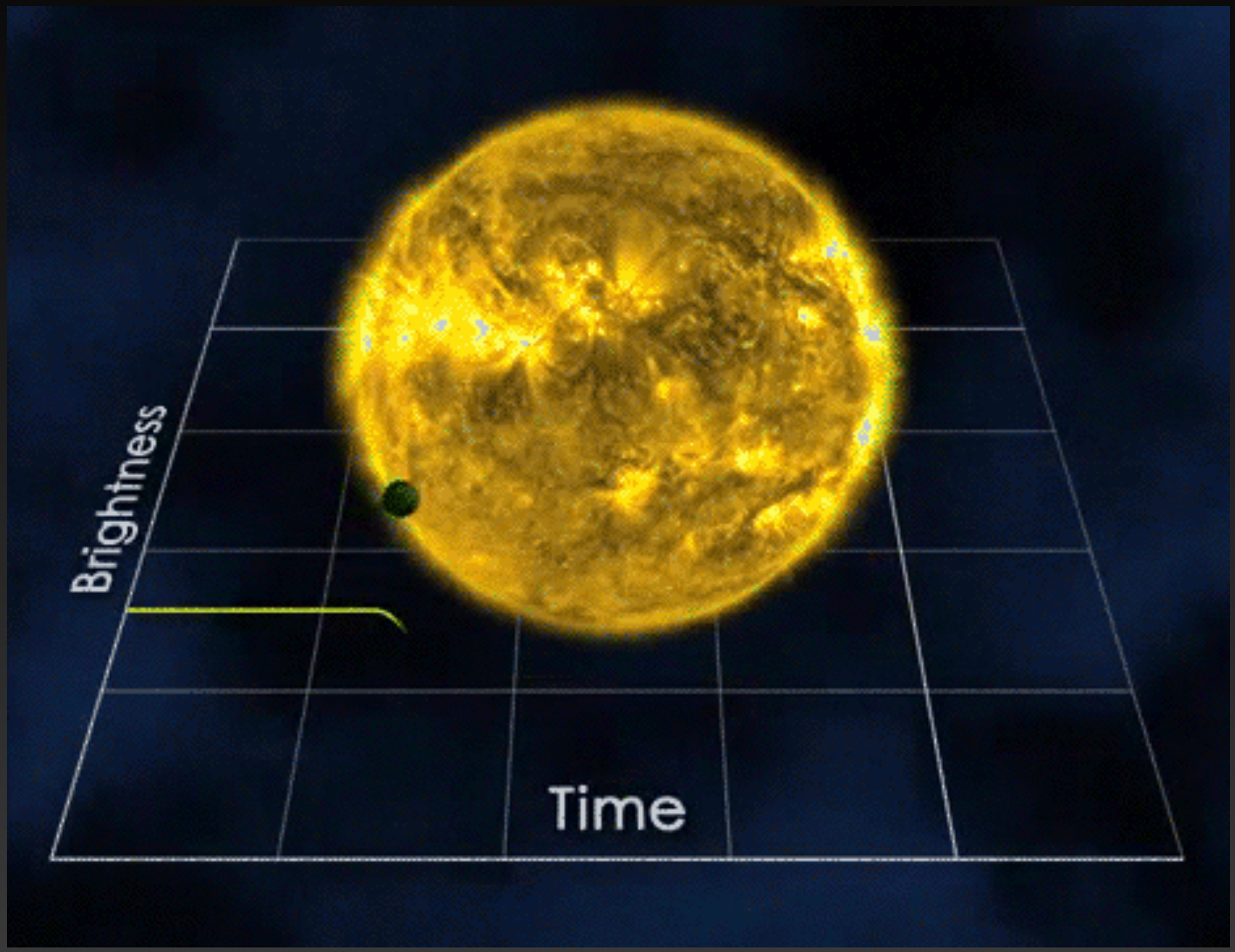
HD131399, SPHERE
Wagner et al. 2016



HIP65426, SPHERE
Chauvin et al. 2017

Scientific objectives

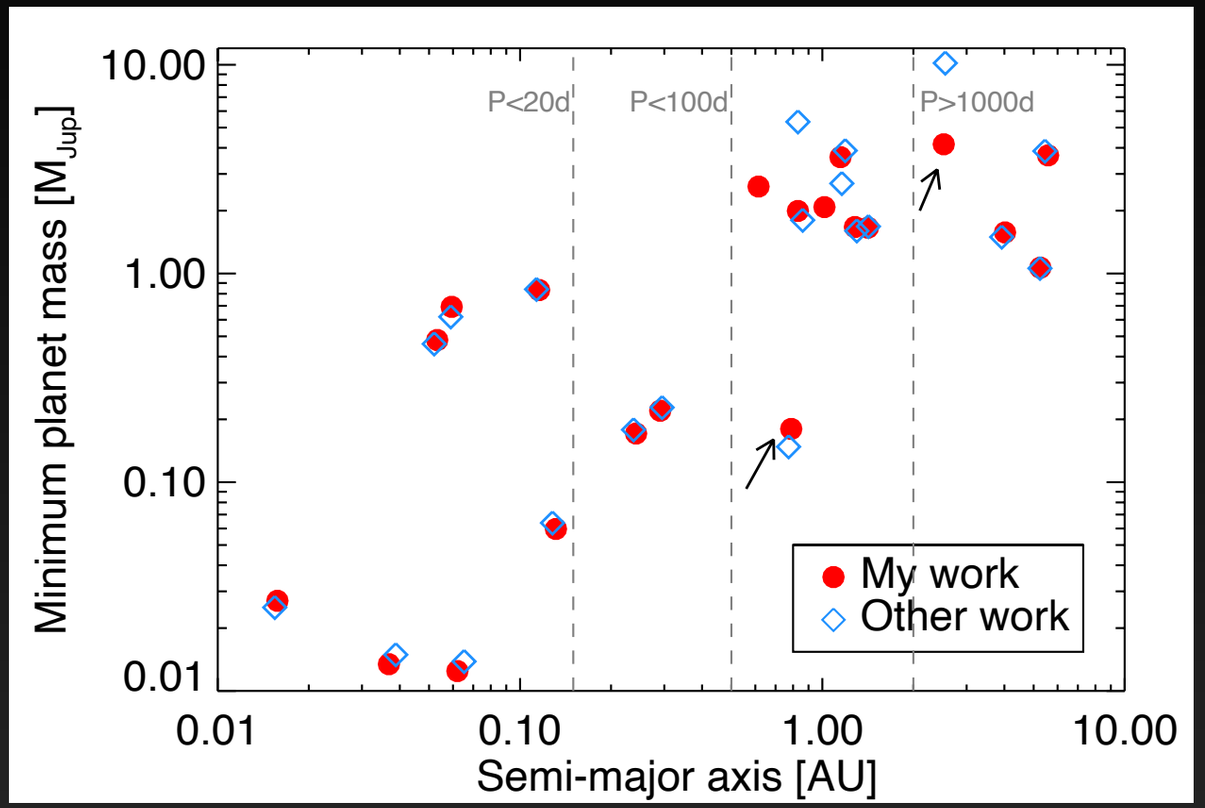
The characterisation of exoplanetary systems

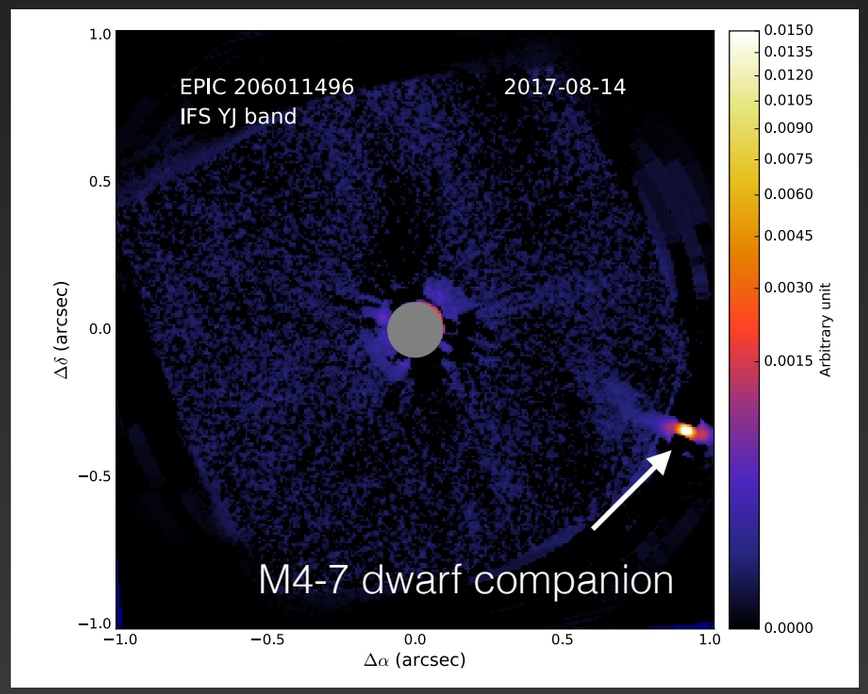


Scientific objectives

The characterisation of exoplanetary systems

- RV
  - We can « only » improve the parameters
  - Still degenerate
- Direct imaging
  - Always need a model
- Transits
  - Can do much better!

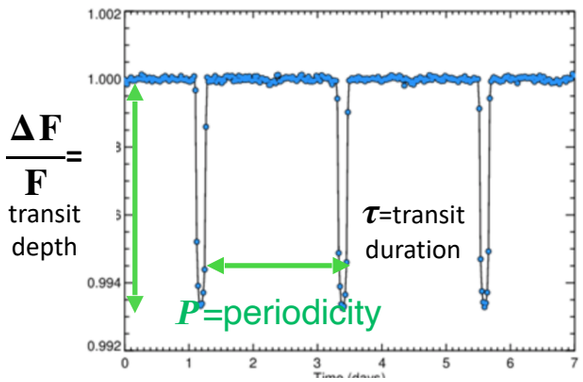




Scientific objectives

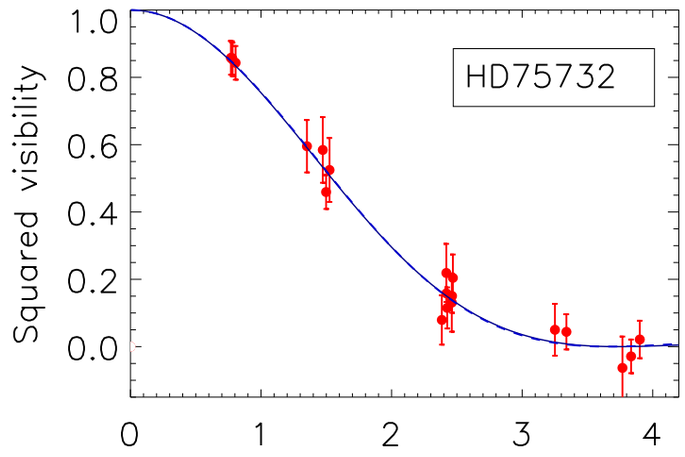
Focus on systems with transiting exoplanets

PHOTOMETRY of stars hosting exoplanets in transit: PLATO, TESS, ...



Transit duration:
$T=2R_\star/a\Omega$
Period: $P = 2\pi/\Omega$

INTERFEROMETRY : θ



$P/T^3 = (\pi^2 G/3)\,\rho_\star$

Measure of stellar density $\rho_\star$

(Maxted et al. 2015, Seager & Mallén-Ornelas 2003)

Measure of $R_\star$ by interferometry within the ISSP survey

Direct measurement of the stellar mass

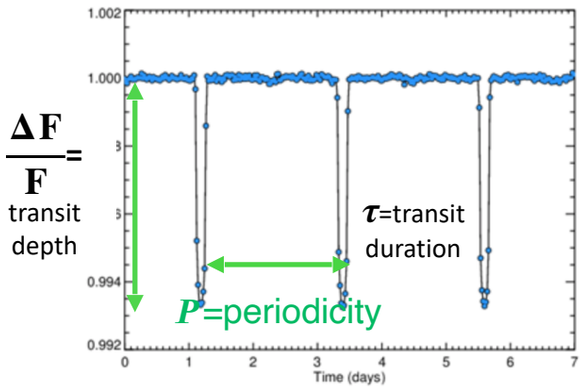
$M_\star=(4\pi/3)R_\star^3\rho_\star$

(Ligi et al. 2016)

Scientific objectives

Focus on systems with transiting exoplanets

PHOTOMETRY of stars hosting exoplanets in transit: PLATO, TESS, ...



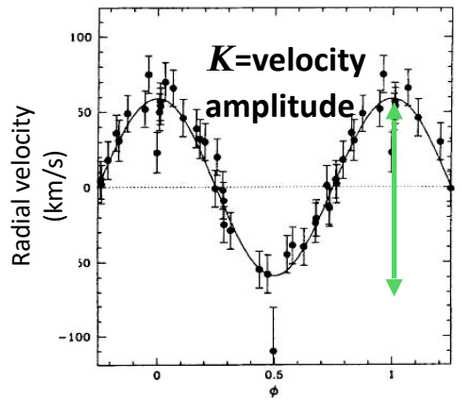
Transit light curve:

$R_p = R_\star \times \sqrt{TD}$

VELOCIMETRY of exoplanets in transit

RV measurements:

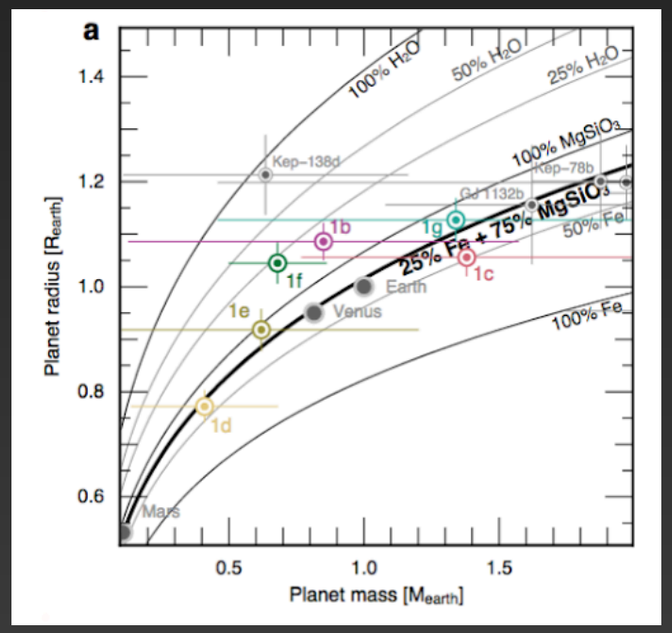
$m_p \sin(i) = M_\star K (P/2\pi G M_\star)^{1/3}$



→ Planetary density

ρ_p

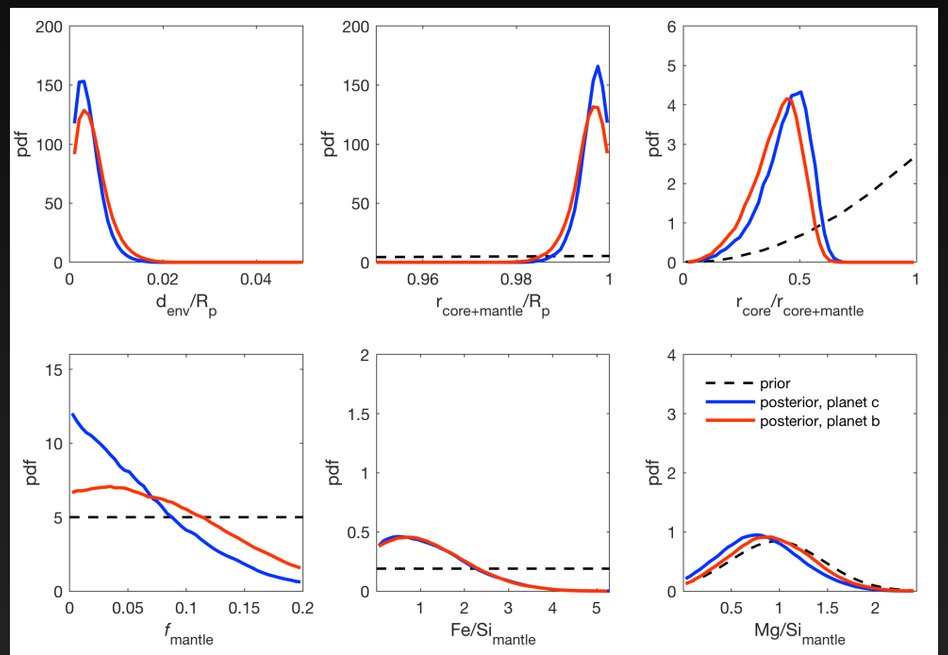
→ Composition of exoplanets

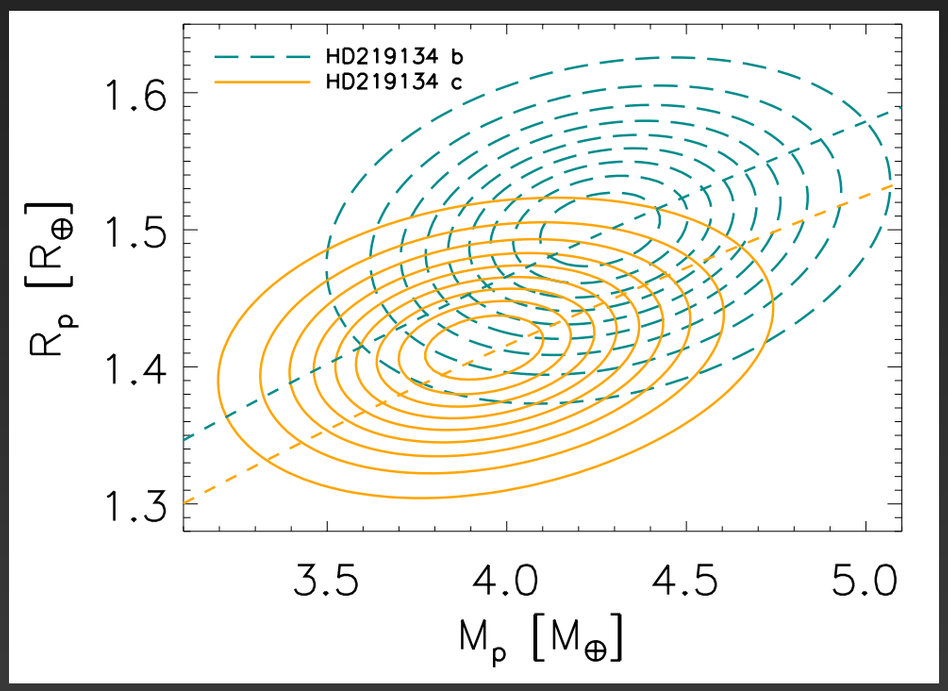


Scientific objectives

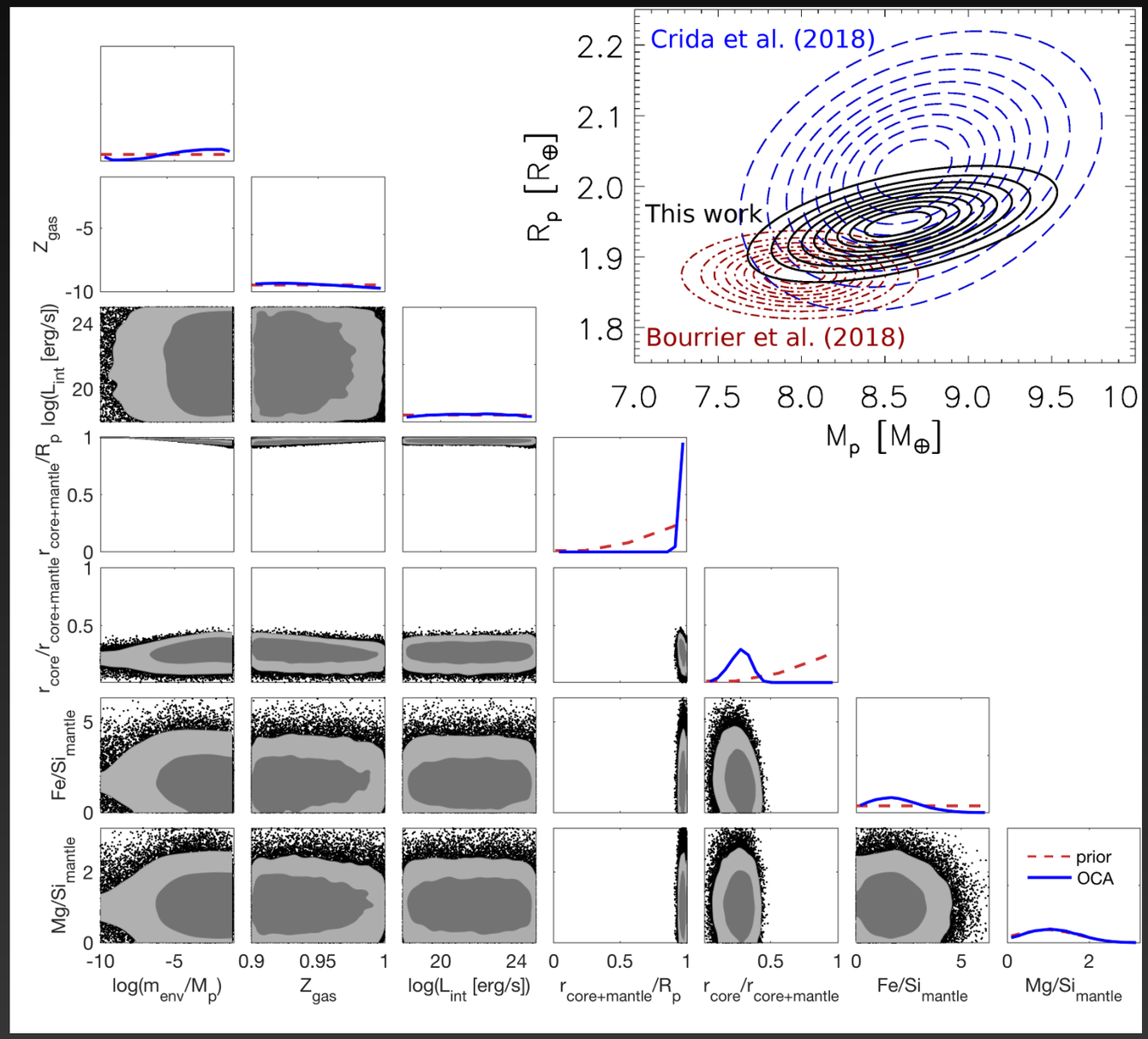
Focus on systems with transiting exoplanets

HD219134





55 Cnc



Scientific objectives

Transiting exoplanets systems

➔ Composition of exoplanets

➔ Understand the Fulton gap (photo-evaporation)

➔ Terrestrial planets with host stars of different metallicities: elemental abundances of the heavier elements correlated between planets and stars?

➔ Evolution of exoplanets atmospheres (age) and orbital dynamics.

Other systems

- Obliquity measurement: remove the *sin(i)*
  - Need high spectral resolution (resolve absorption lines ➔ orientation of the stellar spin axis projected on the sky plane)
  - Planetary orbit from Gaia

  ➔ measure the relative angle between the stellar spin and the planetary angular momentum: the obliquity.
- 51 Eri for imaging
  - More generally, photocenter shift due to spots
- Limb-darkening (2 stars) determination, to compare with LD in transit studies.

Scientific objectives

Transiting exoplanets systems mainly

- Stellar parameters

Direct: $M_\star$ $R_\star$ $\rho_\star$

Derived: T_{eff} log(g) age

To be compared with asteroseismic parameters when possible

Benchmarks!

- Planetary parameters

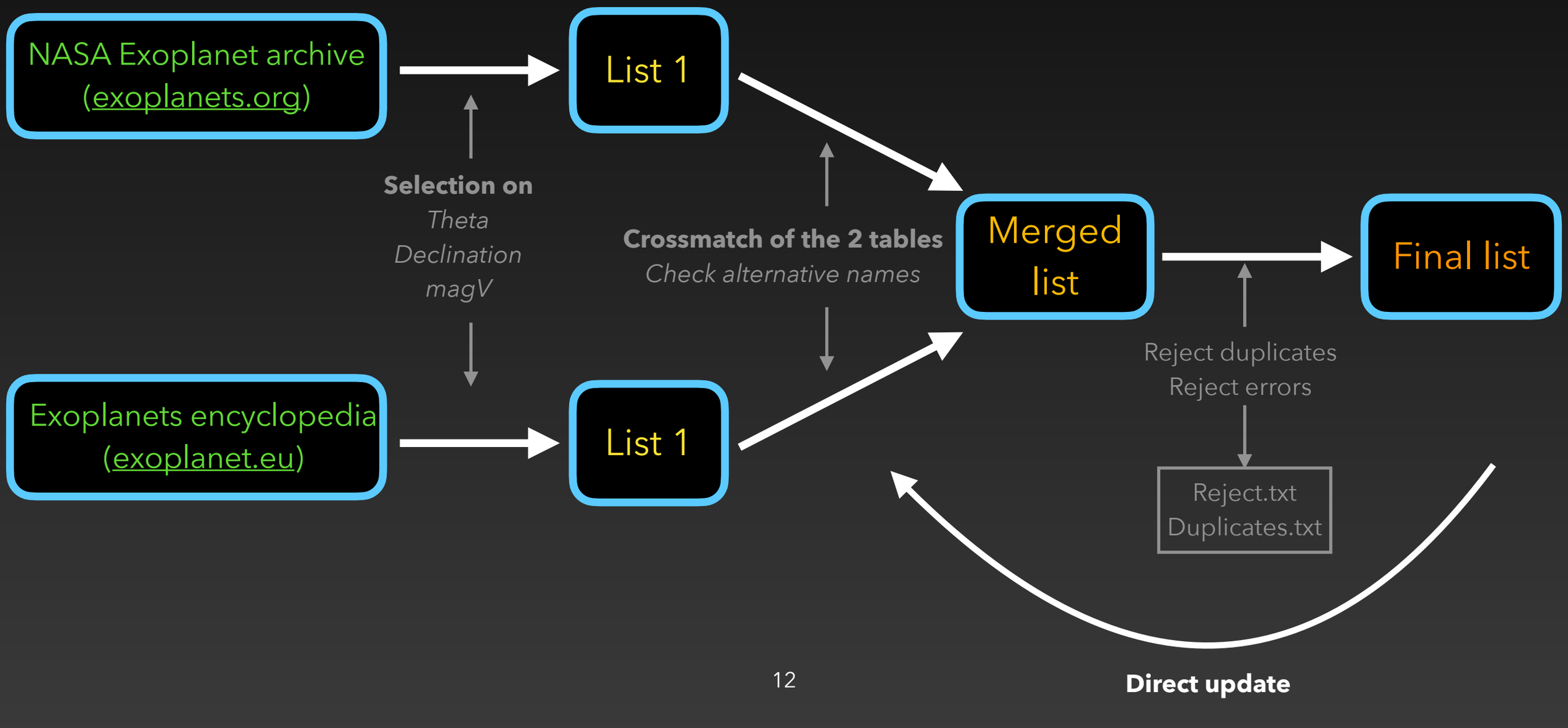
Direct: M_p R_p ρ_p

Composition
Evolution

Target selection

Transiting exoplanetary systems

- No 100% complete database
- All have their own characteristics (column names…)
- All include mistakes



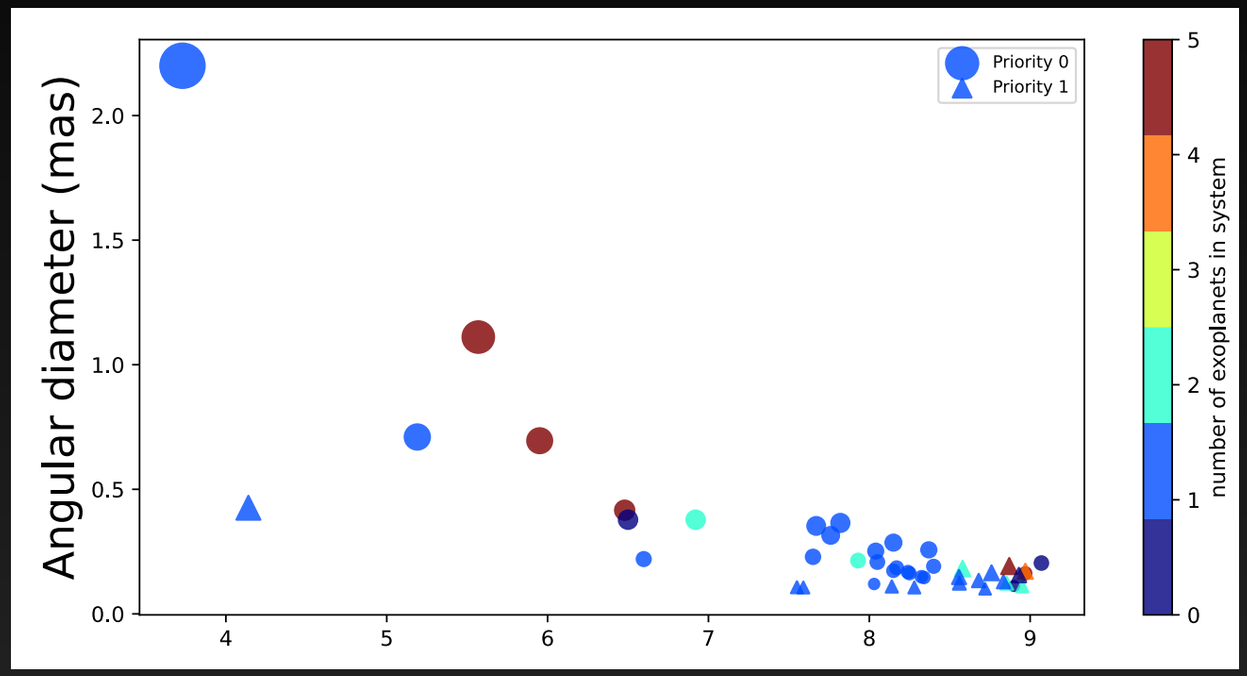
Target selection

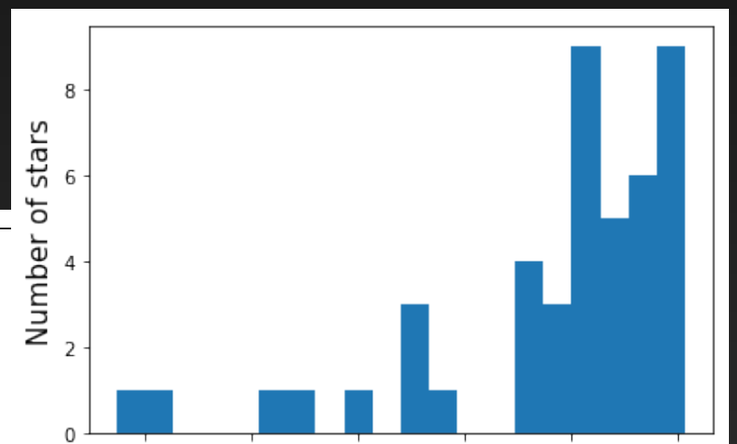
The sample

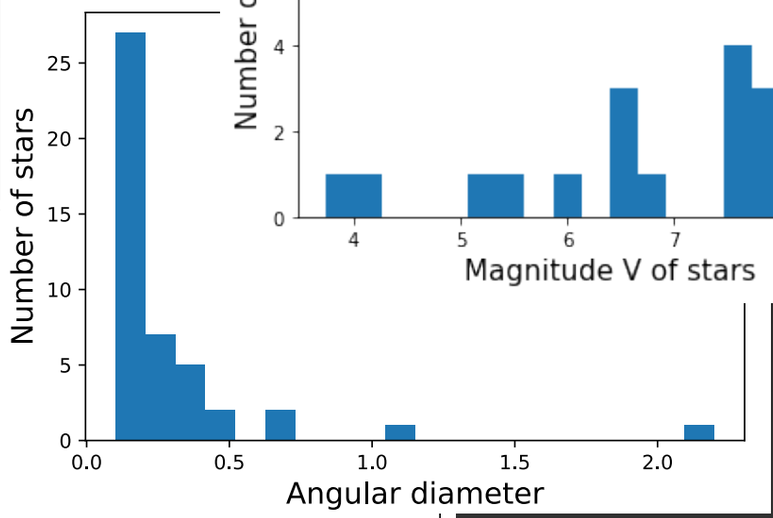
45 stars

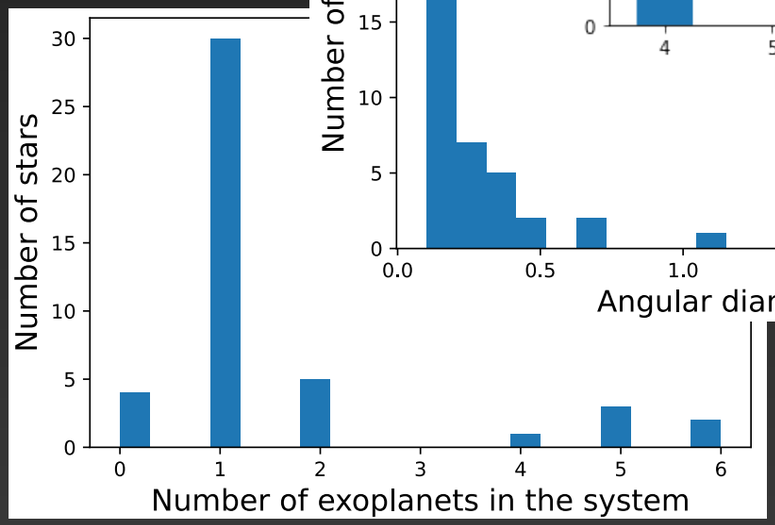
42 with transiting exoplanets
3 detected by direct imaging
(for LD and imaging)

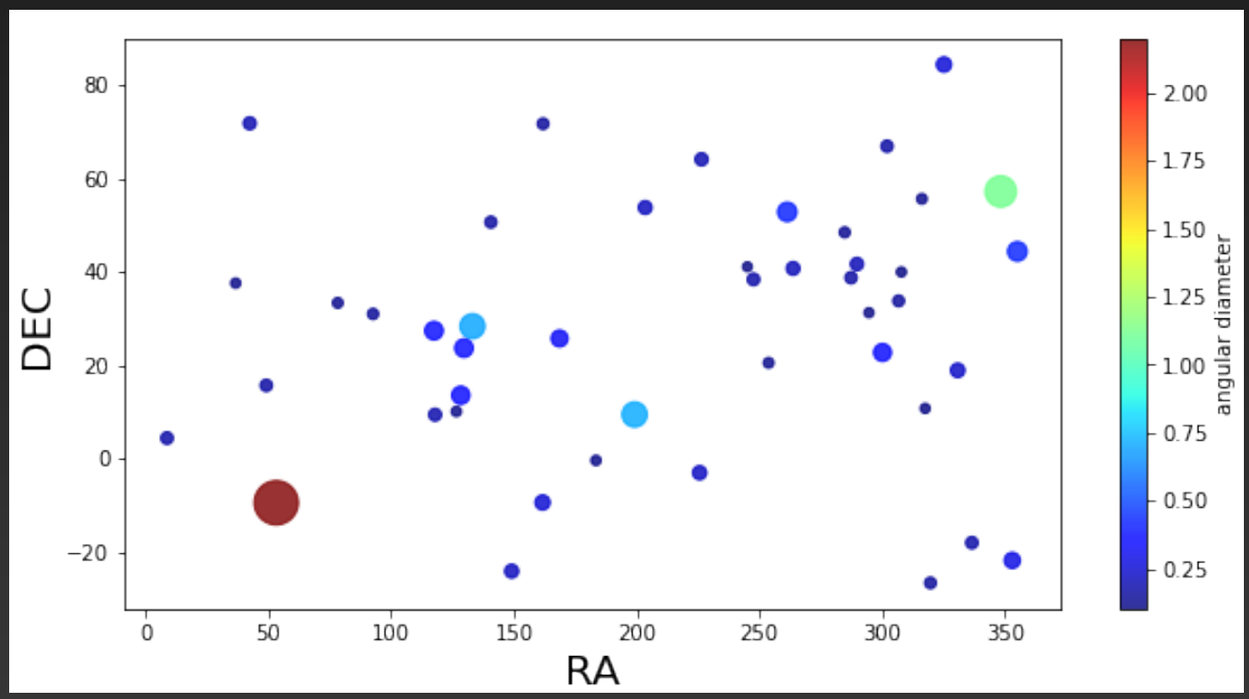
MagV < 9
$\theta_\star$ > 0.1 mas







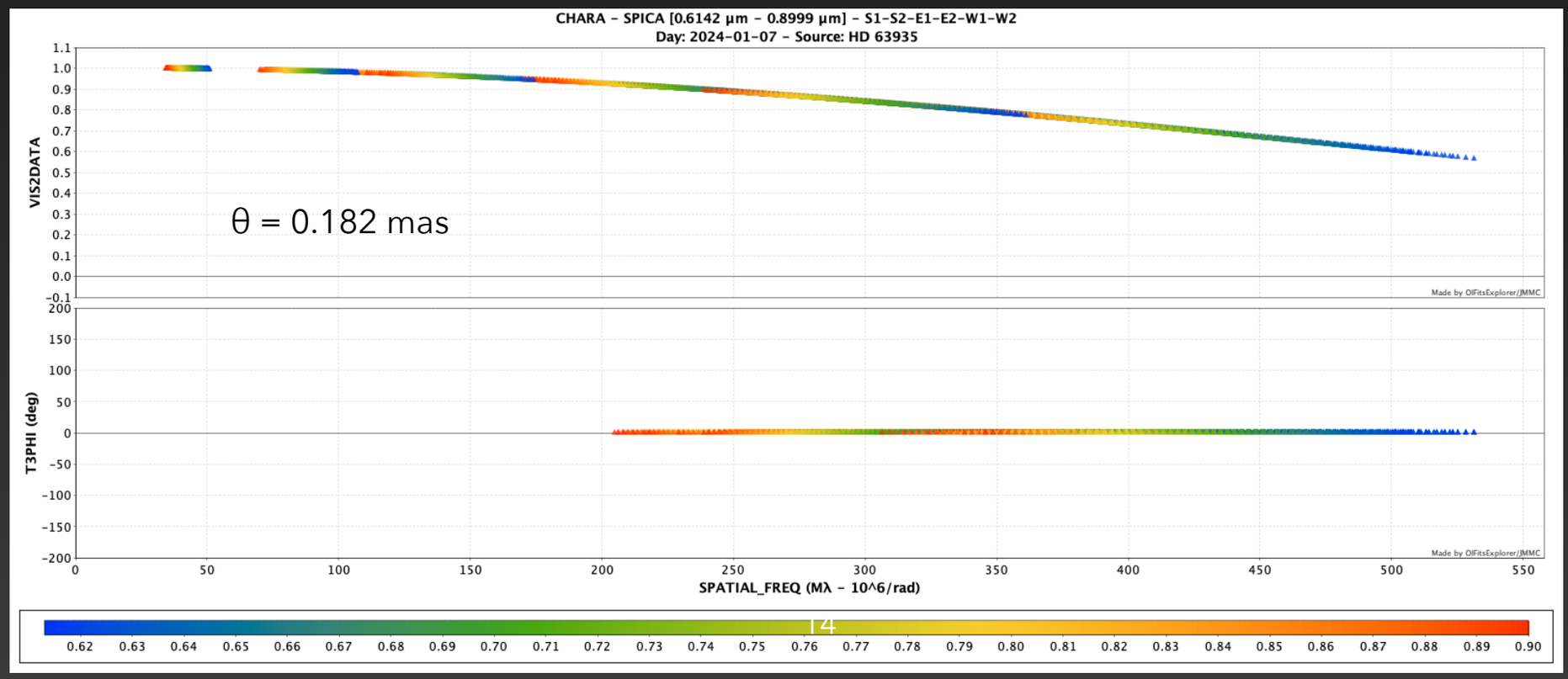




Observation requirements

Transiting exoplanetary systems

- Mainly diameters: 2x 6 telescopes with calibrated visibilities
- Very good precision required (1%)
  - Small stars → high visibilities
- But in any case, the measurements, even if not very precise (<2%), will be better than what is actually done (i.e. models).



Additional tools and data

For the program

- Parallaxes: distances (Gaia) → already available
- Photometry: F_{bol} for T_{eff} → to be computed in the S01 program
- Transit +RV data (literature) → already available but need to be checked

- Stellar models (isochrones) (mass comparison, age) → available

- Planetary models ? → availability? (For many stars)
- Gaia astrometry → check the targets
- Spectra from SPICA → check resolution

Publication strategy

Transiting exoplanetary systems

- Case by case papers (ex. 55 Cnc, HD219134) if a deep analysis is possible
  - Requires the use of planetary interior models
  - Really depends on the SPICA results
- 1 general paper OR include the results in a general SPICA paper at the end of the survey?
  - To be discussed

Thank you

ISSP Meeting - Nice, May 2023