# High-resolution imaging:

## Need for imaging follow-up in the Gaia era


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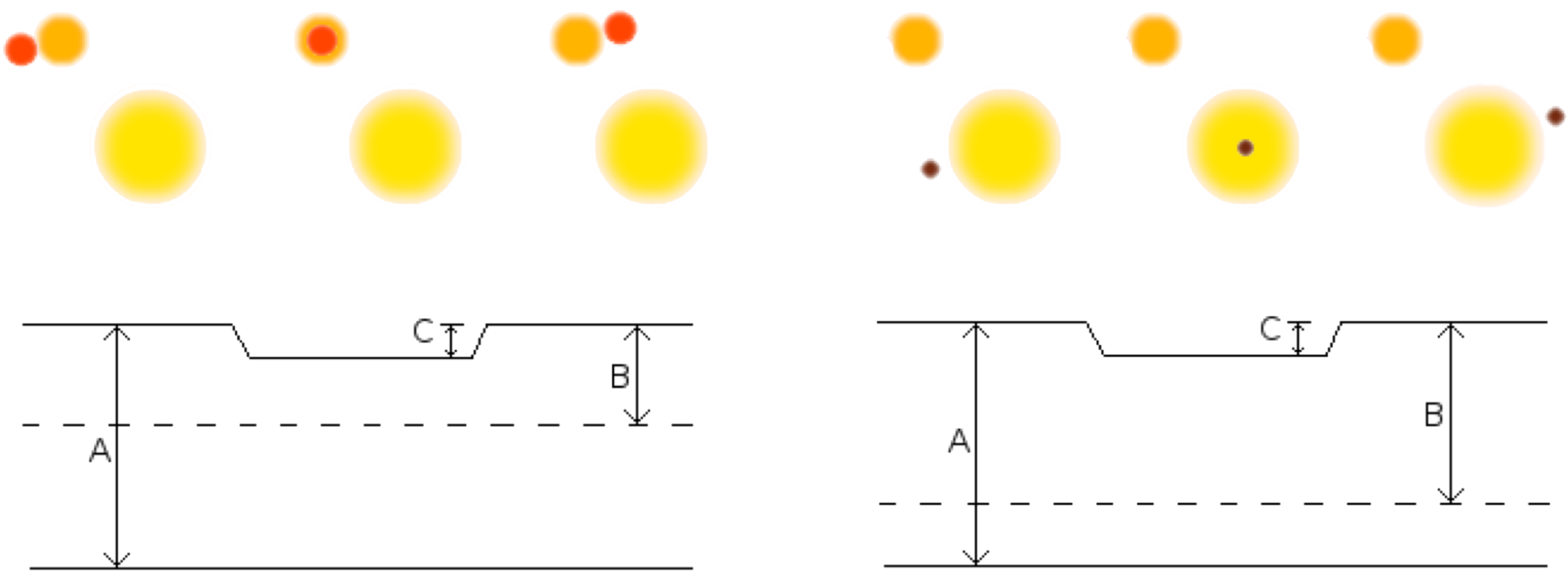
PLATO GOP meeting 2022

# PLATO science requirements

R-SCI-L0-01: PLATO shall detect and characterise hundreds of planets around dwarf and subgiant stars of spectral types from F5 to K7, orbiting at distances up to the stellar habitable zones.

R-SCI-L0-05: PLATO shall provide photometric data to determine the radius of a planet of the same size as the Earth and orbiting a G0V star of V=10 (goal V=11) with an accuracy better than 3%.

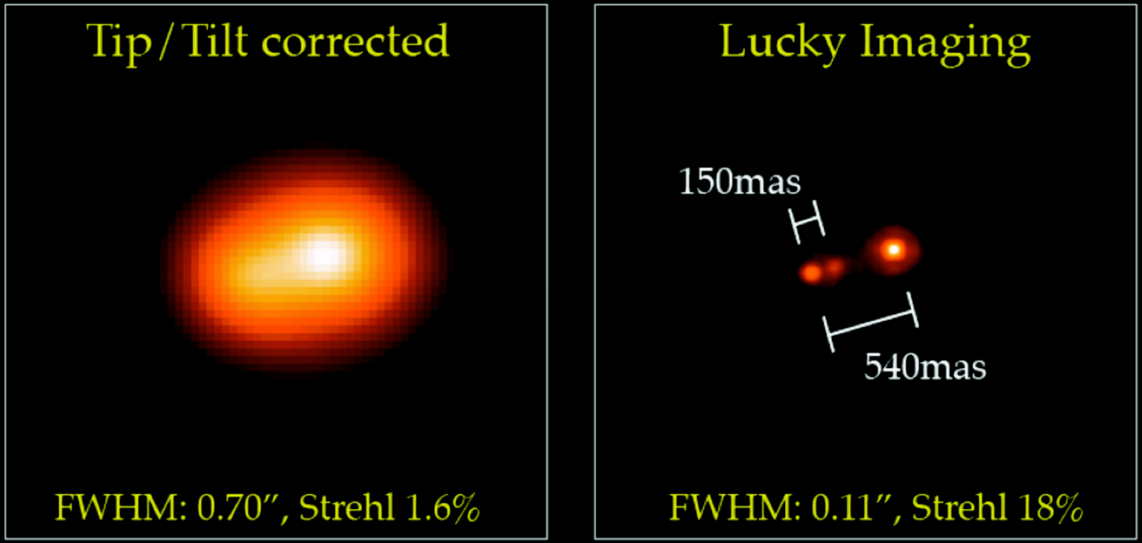
# Issues with unresolved blends




A: Blended continuum
B: Background binary continuum
C: Observed dimming
C/A: Apparent fractional transit depth
C/B: Actual fractional eclipse depth

A: Blended continuum
B: Actual stellar continuum
C: Observed dimming
C/A: Apparent fractional transit depth
C/B: Actual fractional transit depth

# High-resolution imaging
## (with modestly sized telescopes)



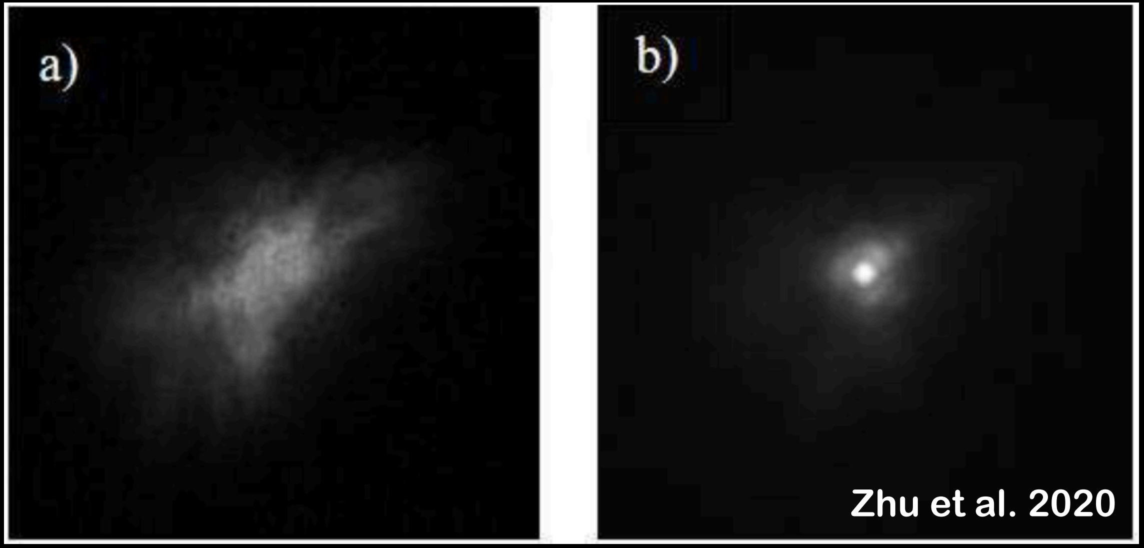

Hippler et al. 2009

**Lucky imaging:**

Operates in the VIS/NIR (~*iz*-band) on 2-4 m telescopes, e.g. AstraLux Sur (NTT visitor instrument).

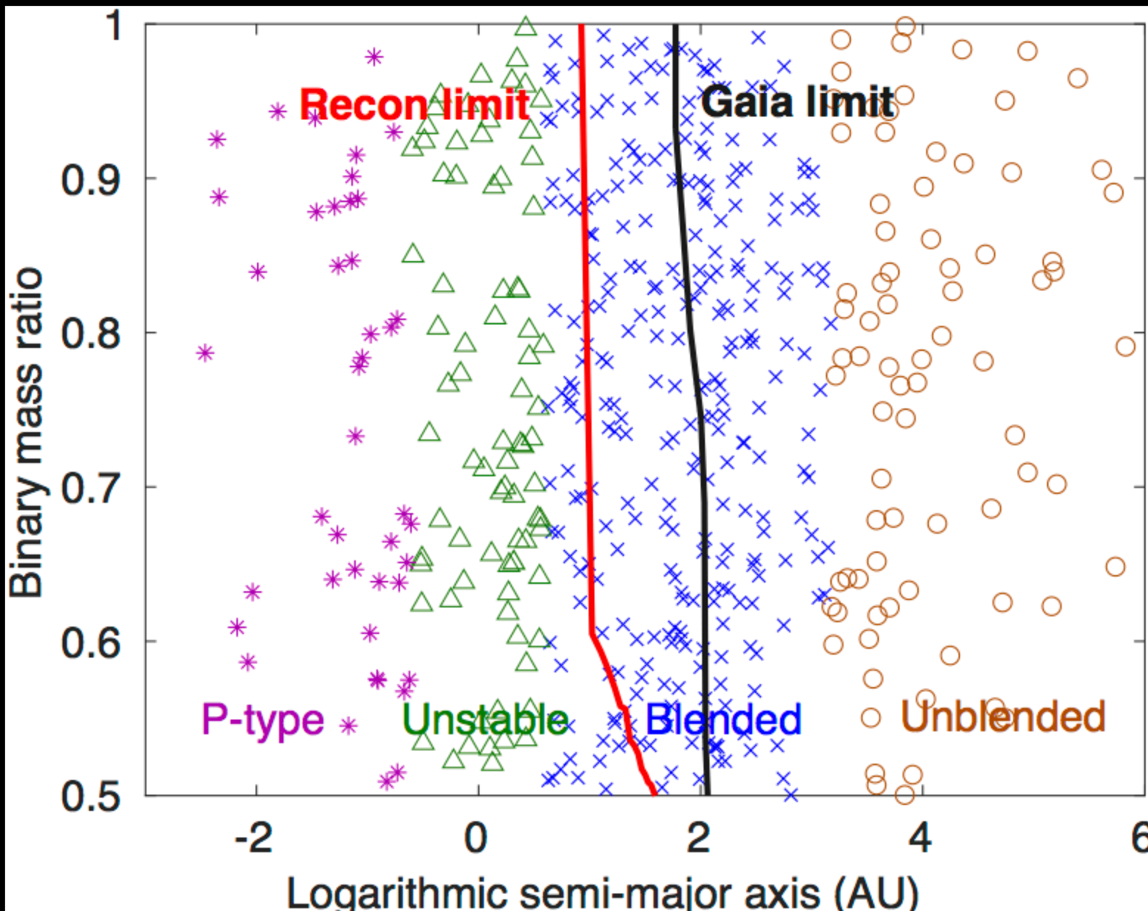
**Adaptive optics:**

Operates in the NIR (~izJ*HK*-band) on 2-4 m telescopes, e.g. PAO (NTT visitor instrument).




Zhu et al. 2020

# Example performance




Template star is G2V at 91.5 pc distance.

~10 min per target => ~40 targets per night, including all necessary calibrations

Gaia performance calculated in Brandeker & Cataldi (2019).

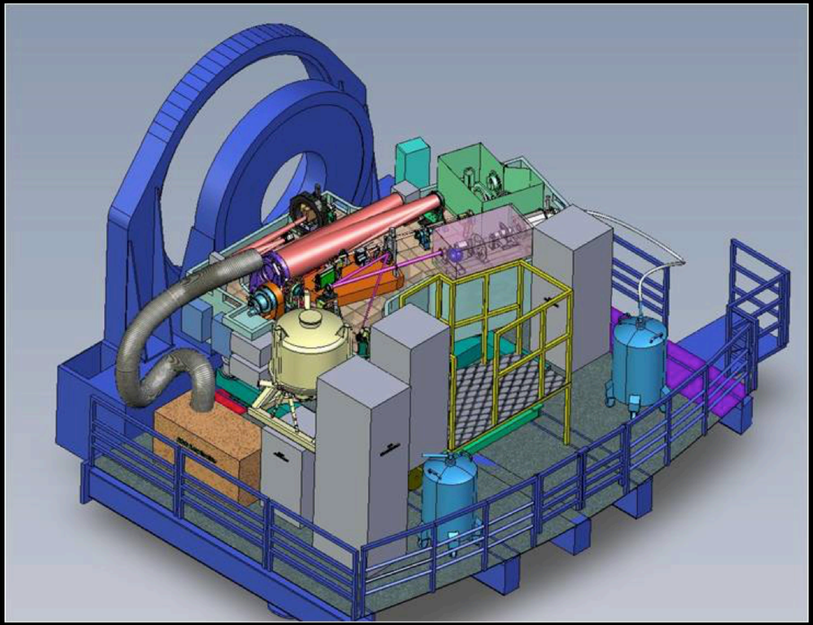
# Potential facilities

| Name | Telescope | Aperture | Owner | Hemisphere |
|---|---|---|---|---|
| SONG Lucky Imager | SONG | 1.0 | Aarhus/Copenh | N |
| KALAO | Swiss /La Silla | 1.2 | Geneva | S |
| Lucky Imager | Danish/La Silla | 1.54 | Denmark/ESO | S |
| AstraLux | Calar Alto | 2.2 | CSIC | N |
| ROBOAO | Hawaii | 2.2 | UH | N |
| AstraLux South | NTT/La Silla | 3.5 | ESO/MPIA | S |
| SPHERE-IRDIS | VLT/Paranal | 8.2 | ESO | S |
| SPHERE-IFS | VLT/Paranal | 8.2 | ESO | S |
| SPHERE-ZIMPOL | VLT/Paranal | 8.2 | ESO | S |
| SHARK-NIR | LBT/M. Graham | 8.4 | LBTO | N |
| LMIRCam | LBT/M. Graham | 8.4+8.4 | LBTO | N |

**The sensitivity of ~2m-class facilities is generally well matched to primary sample, though performance decreases at the faintest end.**

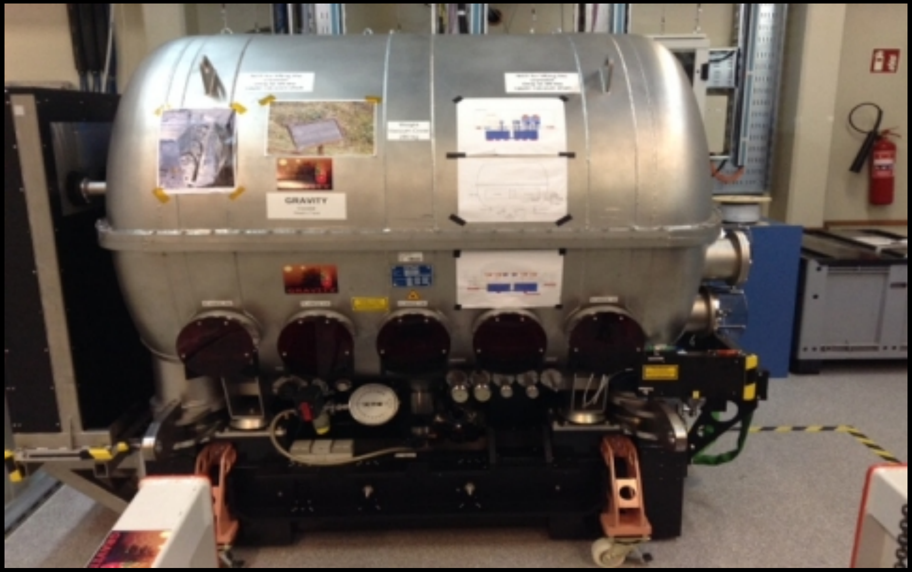
# Heavy artillery
## (for particular cases; WP led by Dino Mesa)

ESO



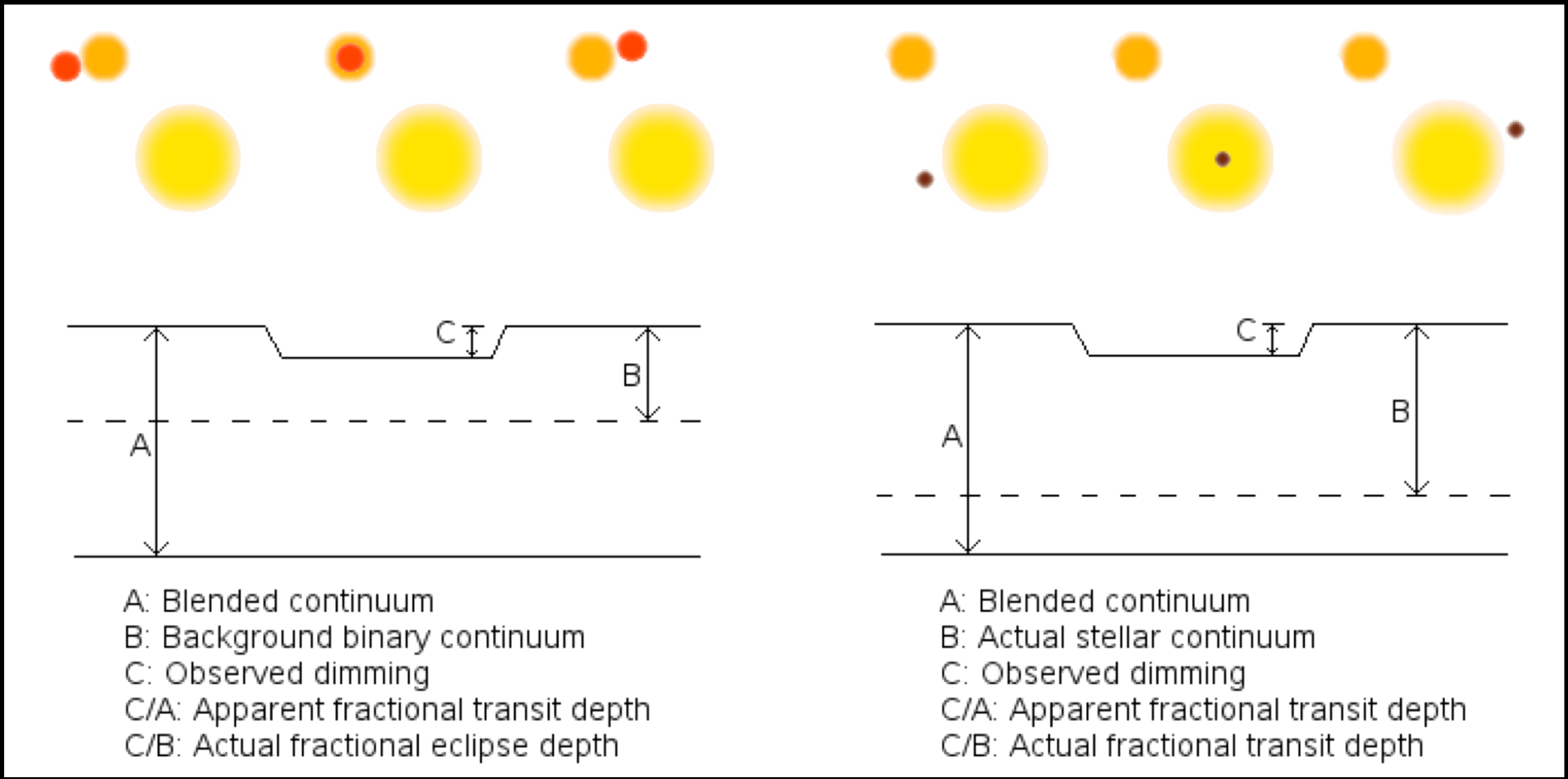
SPHERE: Extreme AO, star-hopping RDI, 8m telescope

GRAVITY: Interferometry, ~2 mas resolution for reasonably bright targets



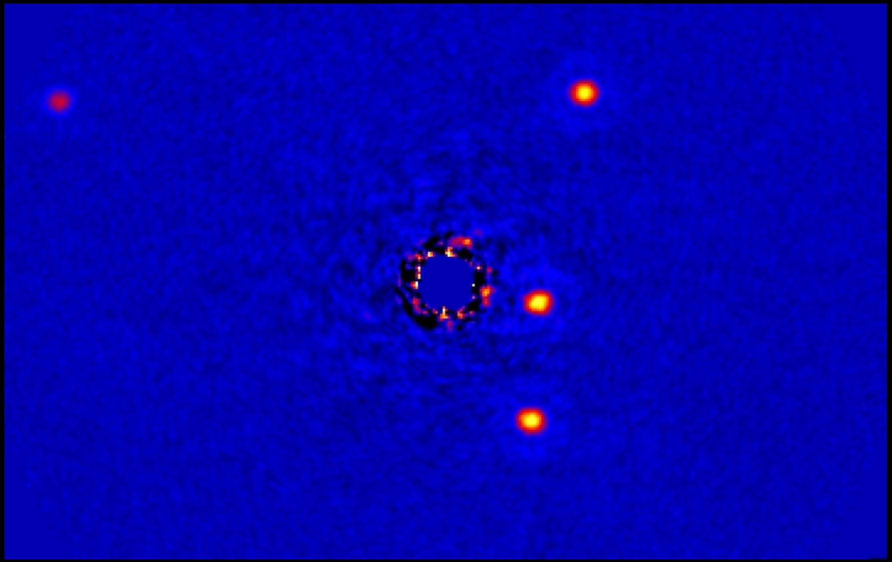

ESO

# Prospects for combining high-resolution and time-critical photometry

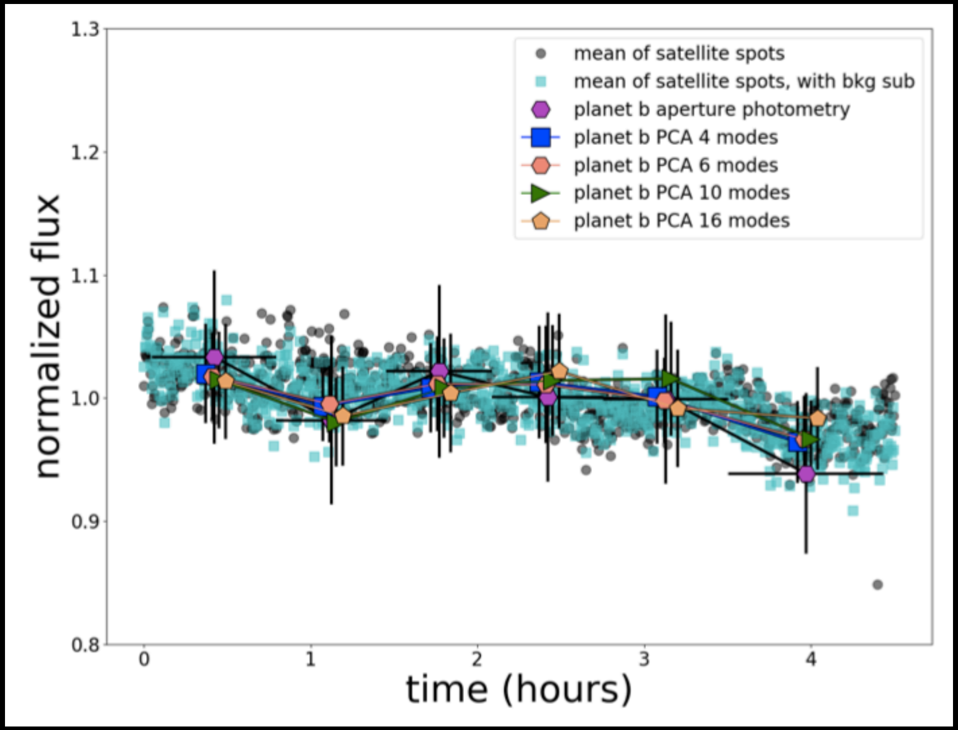



**Resolving a system during eclipse can distinguish pathological cases (but requires timed observations)**

# Prospects for combining high-resolution and time-critical photometry



Resolving a system during eclipse can distinguish pathological cases (but requires timed observations)



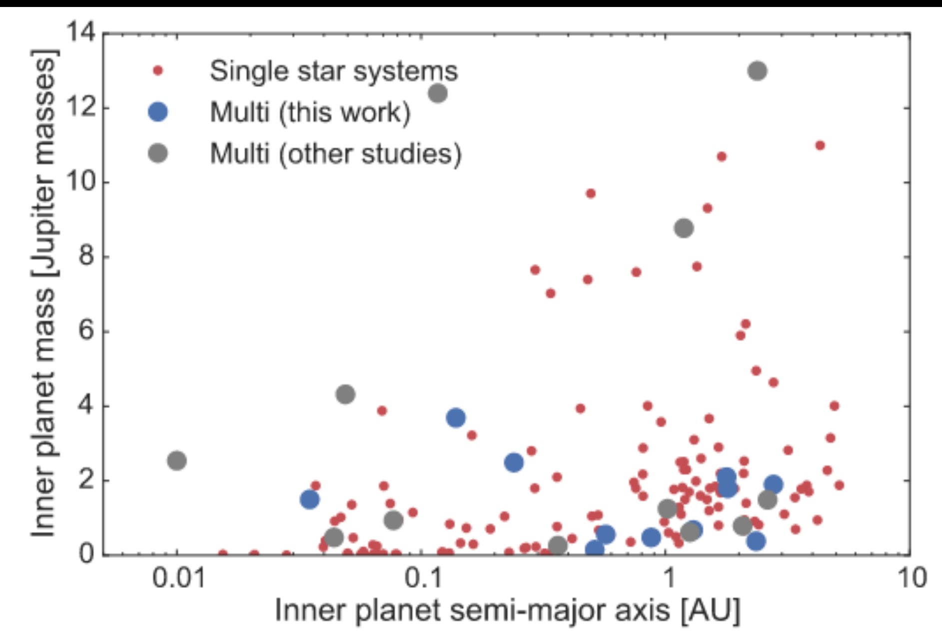

Variability sensitivity for the resolved HR 8799 planets corresponds to an unresolved variability of $10^{-4} – 10^{-5}$

=> Basically every possible false positive eclipsing binary is within reach (but mind the longitude!)

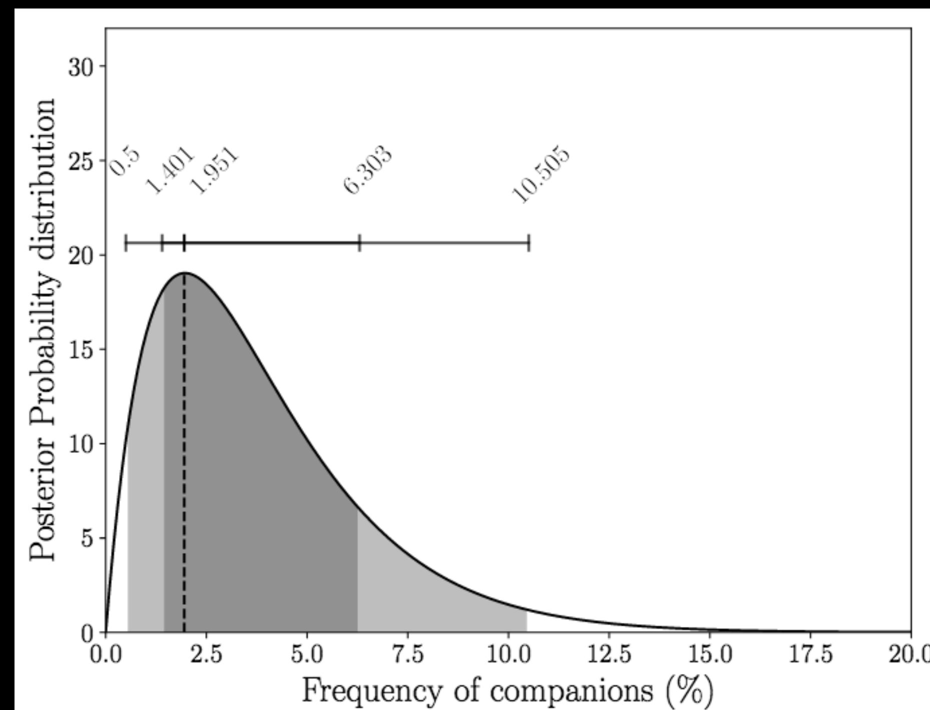
Biller et al. 2021

# Ancillary science
## (not encompassed by the science requirements)

Ngo et al. 2017




Approximately half of all Sun-like stars are in binary systems




How planetary systems depend on parent multiplicity is an important aspect for planet formation and habitability.

Asensio-Torres et al. 2018