

Searching for Earth-sized planets around brown dwarfs with SAINT-EX

An ongoing photometric survey from San Pedro Mártir, México

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Do Earth-sized planets orbit brown dwarfs? – No detection yet

Small planets form around low mass stars

M dwarfs host 3–4× more small planets than FGK stars, and occurrence rises as host mass drops (Sabotta et al. 2021; Mulders et al. 2021).

Brown dwarfs form disks

Disks have been found around young brown dwarfs, but Earth-mass planets are unlikely if the disk mass is $< 1 M_{\text{Jup}}$ (Payne & Lodato 2007; Rilinger & Espaillat 2021).

Occurrence is unconstrained

Only upper limits exist: $\leq 67\%$ for short-period (< 1.8 d) small ($0.75\text{--}3.25 R_{\oplus}$) planets, leaving formation models untested (e.g. He et al. 2017).

The SAINT-EX Observatory



Robotic 1-m telescope at 2780 m, San Pedro Mártir, México. Image Credit: E. Cadena

- ★ SAINT-EX: Search And characterisation of Transiting EXoplanets. (Gómez Maqueo Chew, Y. et al. 2023)
- ★ Robotic 1-m F/8 Ritchey-Chrétien telescope
- ★ Fully robotic & remote since 2019

Survey workflow — from catalog to light curves

Kirkpatrick catalog

L, T, Y dwarfs, 20 pc census

Initial sample

filter binaries

Planet scenario

Earth-sized, 1 Earth irradiation

Transit SNR

SNR > 4 (Sebastian et al. 2021)

Planning Obs.

Coverage + visibility $\rightarrow$ 50 h each

Observe + analyze

STX observation + transit search

72

brown dwarfs in the final sample

~ 50 h

of observing time per target

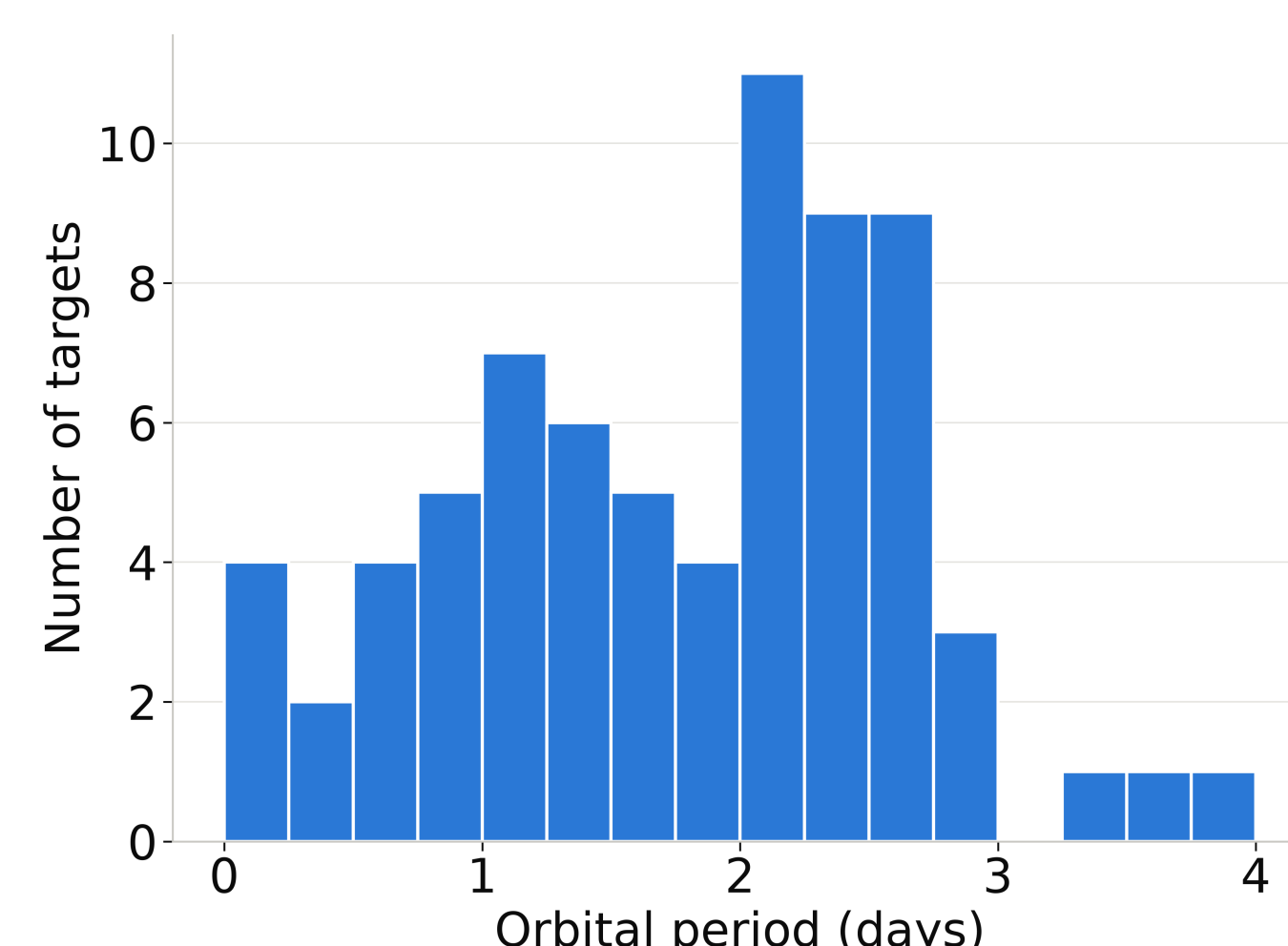
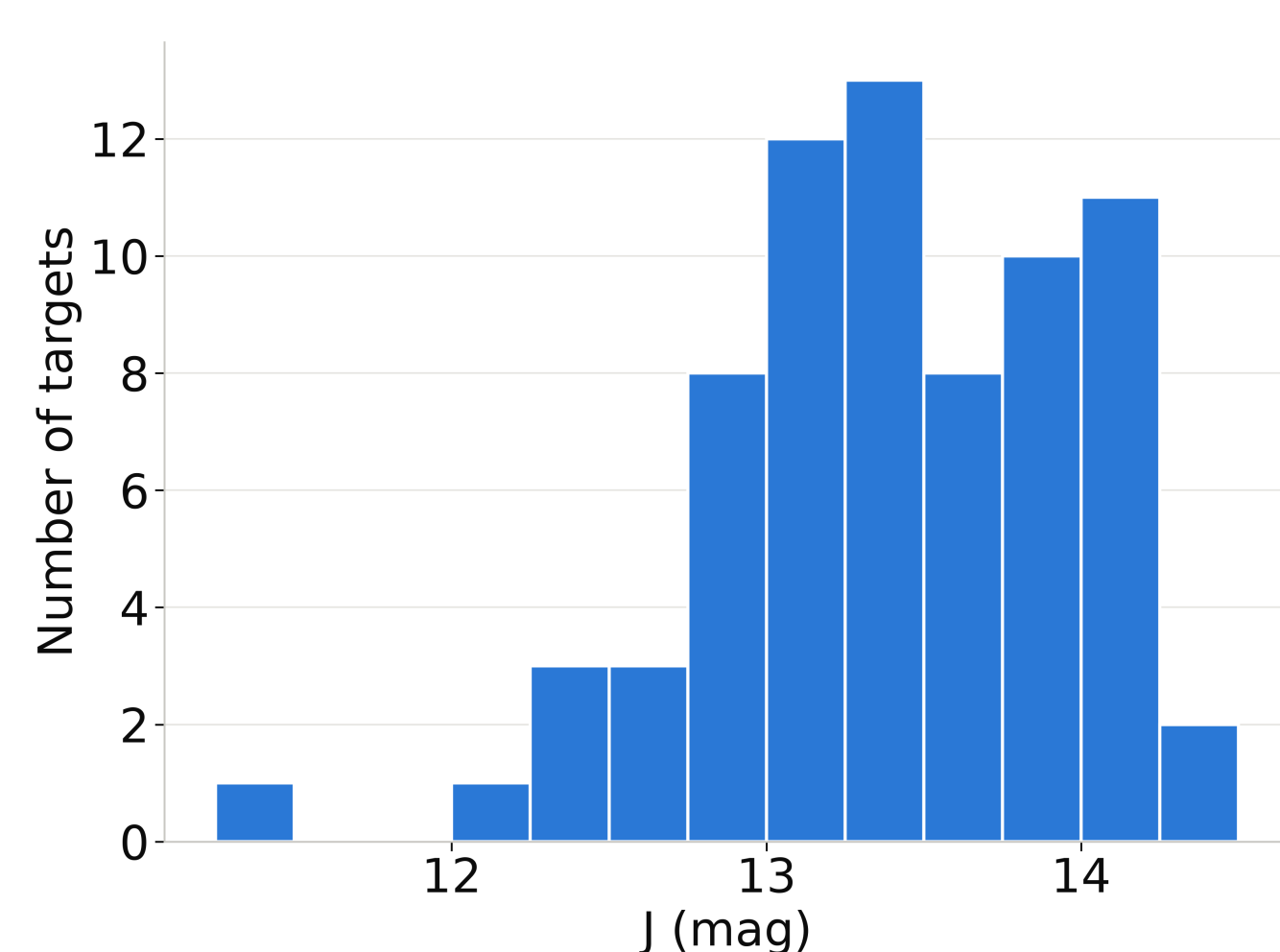
> 80%

phase coverage of an Earth-like planet

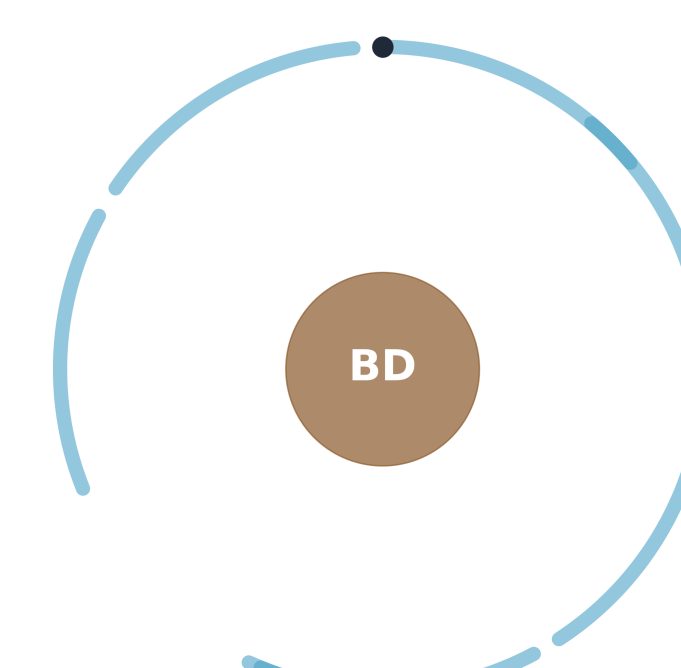
7

brown dwarfs observed so far

The final sample - SNR/transit > 4 (N=72)

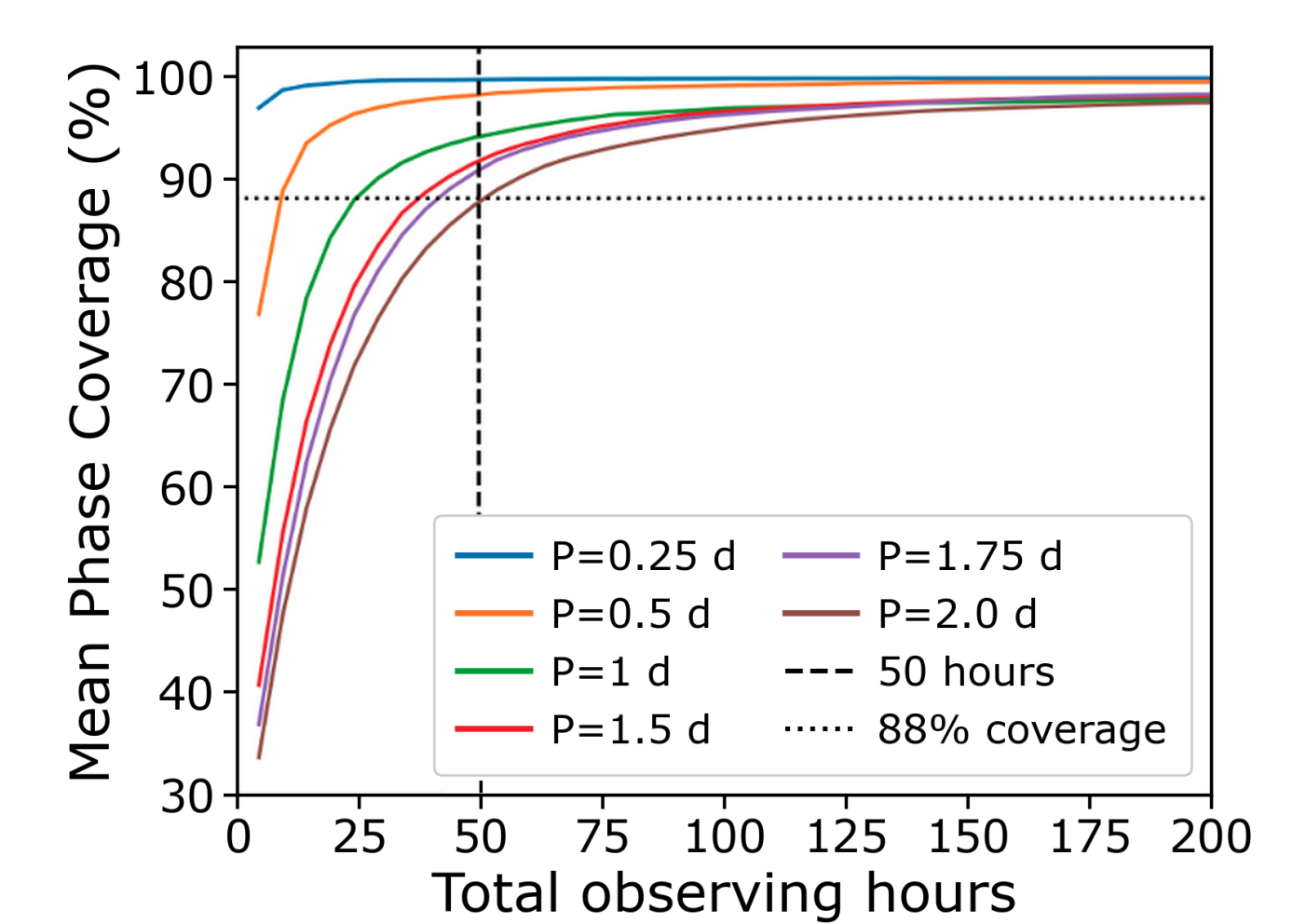


Observing strategy — A planet with $1R_{\oplus}$ and $1S_{\oplus}$

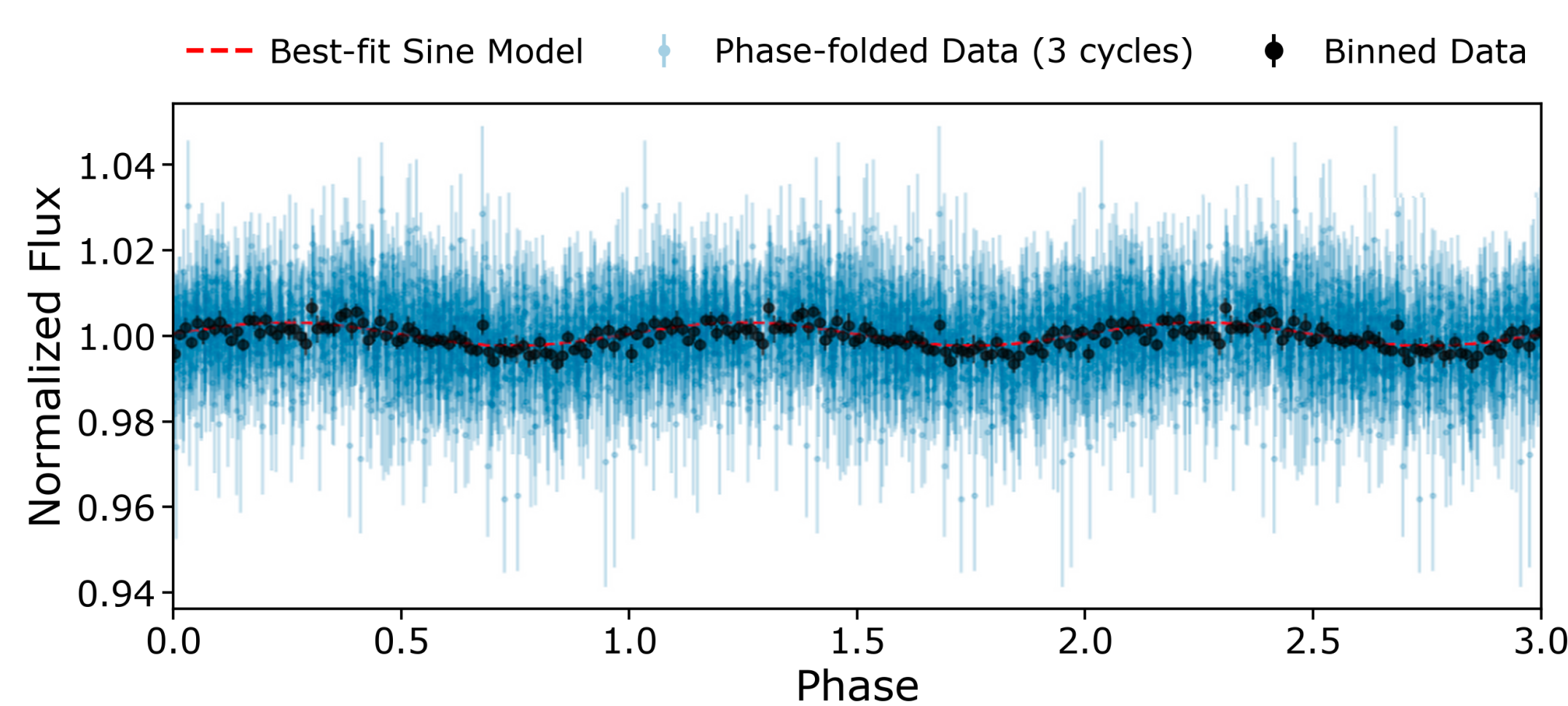


For period 2.37 days coverage is 82.66 %

Each target is observed nightly until ~ 50 h are accumulated, reaching > 80% phase coverage for a planet with Earth-like irradiation (example: Sp1439+1929).

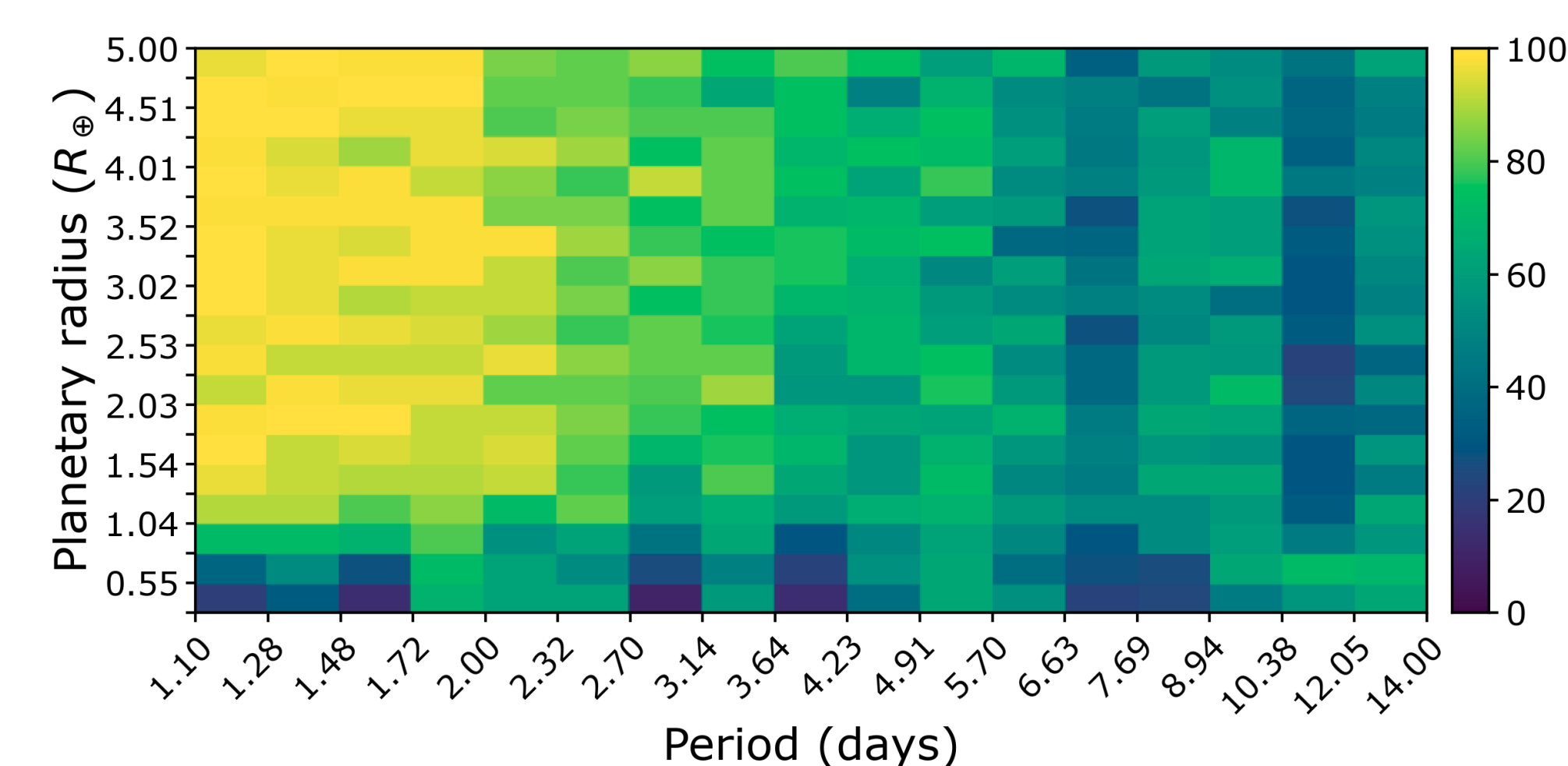


Brown dwarf variability



Phase-folded light curve over three rotation cycles (GLS period $P = 0.1531$ d) with best-fit sine model. The target shows clear spot-driven variability.

Sensitivity to small planets



Example Injection recovery tests: Planet Radius vs Orbital Period colored by recovery rate. Sensitivity reaches $\sim 1 R_{\oplus}$ at short periods (< 2 d).

Summary & conclusions

- ★ The existence of small planets around brown dwarfs remains an **open question**, with no confirmed detections so far.
- ★ Our **final sample** consists of **72 nearby brown dwarfs**.
- ★ With ~ 50 h per target we reach > 80% phase coverage of a planet with Earth-like irradiation.
- ★ **7 brown dwarfs observed** so far.
- ★ Our survey will not only place **limits on planet occurrence** below the substellar boundary, but constrain brown dwarf **rotation and variability**.

References

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