



Status updates of IRD-SSP

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on behalf of the IRD-SSP team



Redefinition of science goals in 2022

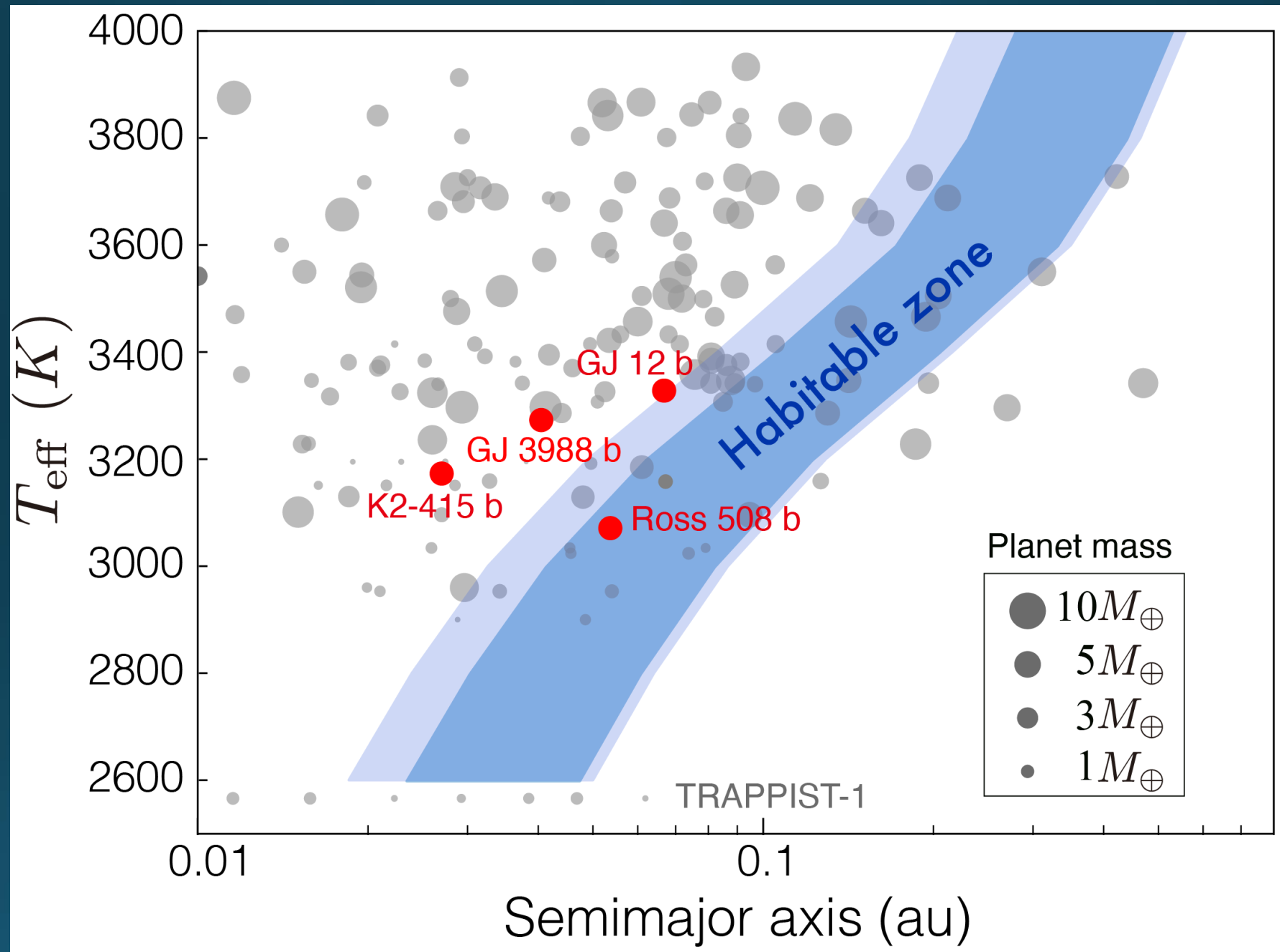
- Minimum Success
 - Detection of >1 terrestrial planets ($m_{\text{ini}} = 1 - 10 M_{\text{Earth}}$)
 - Distribution of giant planets ($> \text{a few } 10 M_{\text{Earth}}$), located up to $\sim 0.1 \text{ a.u.}$ for > 40 stars that can be compared to the result of gravitational microlensing planet.
 - Providing an upper limit on the frequency of HZ planets, $> 3 M_{\text{Earth}}$
- Full Success:
 - Discovery of at least one HZ planet with $m_{\text{ini}} = 1 - 10 M_{\text{Earth}}$
 - Distribution of short-period (orbital period < 10 days), planets $> 3 M_{\text{Earth}}$
 - Frequency of existence of low-mass planets ($> 3 M_{\text{Earth}}$), including HZ planets
- Extra Success:
 - Discovery of one or more HZ planets of about Earth mass ($m_{\text{ini}} = 1 - 3 M_{\text{Earth}}$)
 - Frequency of existence for terrestrial planets ($> 1 M_{\text{Earth}}$), including Earth-mass HZ planets
 - Discovery of Earth-like planets that can be followed up (transit photometry) to understand the atmospheres and internal compositions (e.g. mass-radius relationship)



Publications

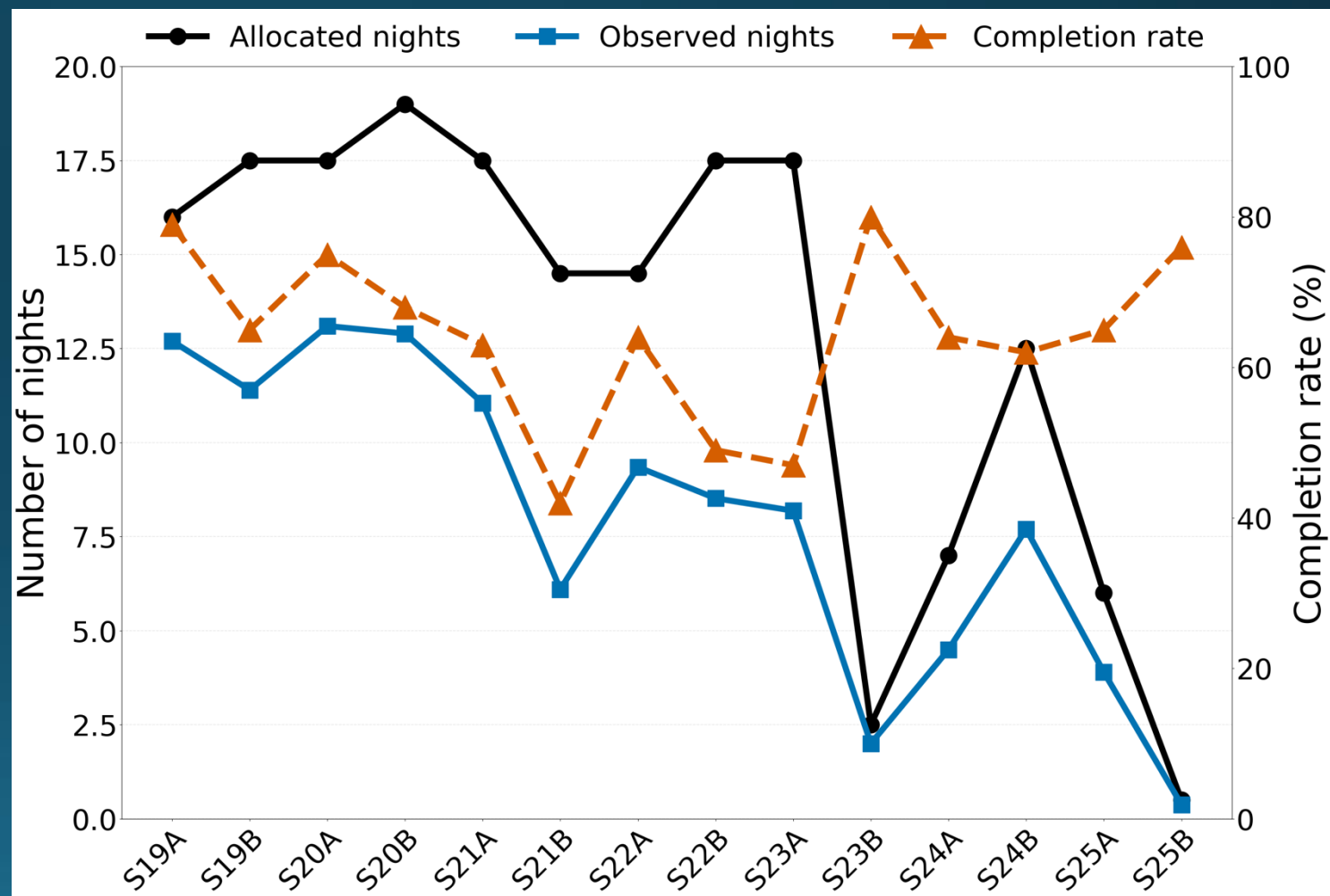
1. "A Super-Earth Orbiting Near the Inner Edge of the Habitable Zone around the M4.5-dwarf Ross 508", Harakawa et al. 2022, PASJ, 74, 904
2. "Elemental Abundances of nearby M Dwarfs Based on High-resolution Near-infrared Spectra Obtained by the Subaru/IRD Survey: Proof of Concept", Ishikawa et al. 2022, AJ, 163, 72
3. "An Earth-sized Planet around an M5 Dwarf Star at 22 pc", Hirano et al. 2023, AJ, 165, 131
4. "Direct Imaging Explorations for Companions around Mid-Late M Stars from the Subaru/IRD Strategic Program", Uyama et al. 2023, AJ, 165, 162
5. "Planetary companions orbiting the M dwarfs GJ 724 and GJ 3988: A CARMENES and IRD collaboration", Gorrini et al. 2023, A&A, 680, 28
6. "Gliese 12 b: A Temperate Earth-sized Planet at 12 pc Ideal for Atmospheric Transmission Spectroscopy", Kuzuhara et al. 2024, ApJ, 967, id.L21
7. "The CARMENES search for exoplanets around M dwarfs: Revisiting the GJ 317, GJ463, and GJ 3512 systems and two newly discovered planets orbiting GJ9773 and GJ 508.2", Morales et al. 2025, A&A, 700, id.A242
8. "Direct Imaging Explorations for Companions from the Subaru/IRD Strategic Program II; Discovery of a Brown-dwarf Companion around a Nearby Mid-M-dwarf LSPM J1446+4633", Uyama et al. 2025, AJ, 170, id.272
9. "Discovery of Two Brown-dwarf Companions around XXXX and YYYY from the Subaru/IRD Strategic Program Combined with GAIA Astrometry", Takarada et al. 2026, to be submitted

Discovery of 6 planets (5 hosts) and 3 brown dwarfs



Observation progress from S19A to S26A

- A total of 175 nights allocated for S19A~S23B period
- 25.5 nights lost due to troubles (telescope, detector, COVID-19). The nights are compensated in S24A-S25B.
- 174.5 nights were used for IRD-SSP by October 2025.
- Remaining 0.5 nights allocated in S26A will be cancelled due to IRD and AO trouble.
- We will request compensation of the 0.5 nights in later semester.

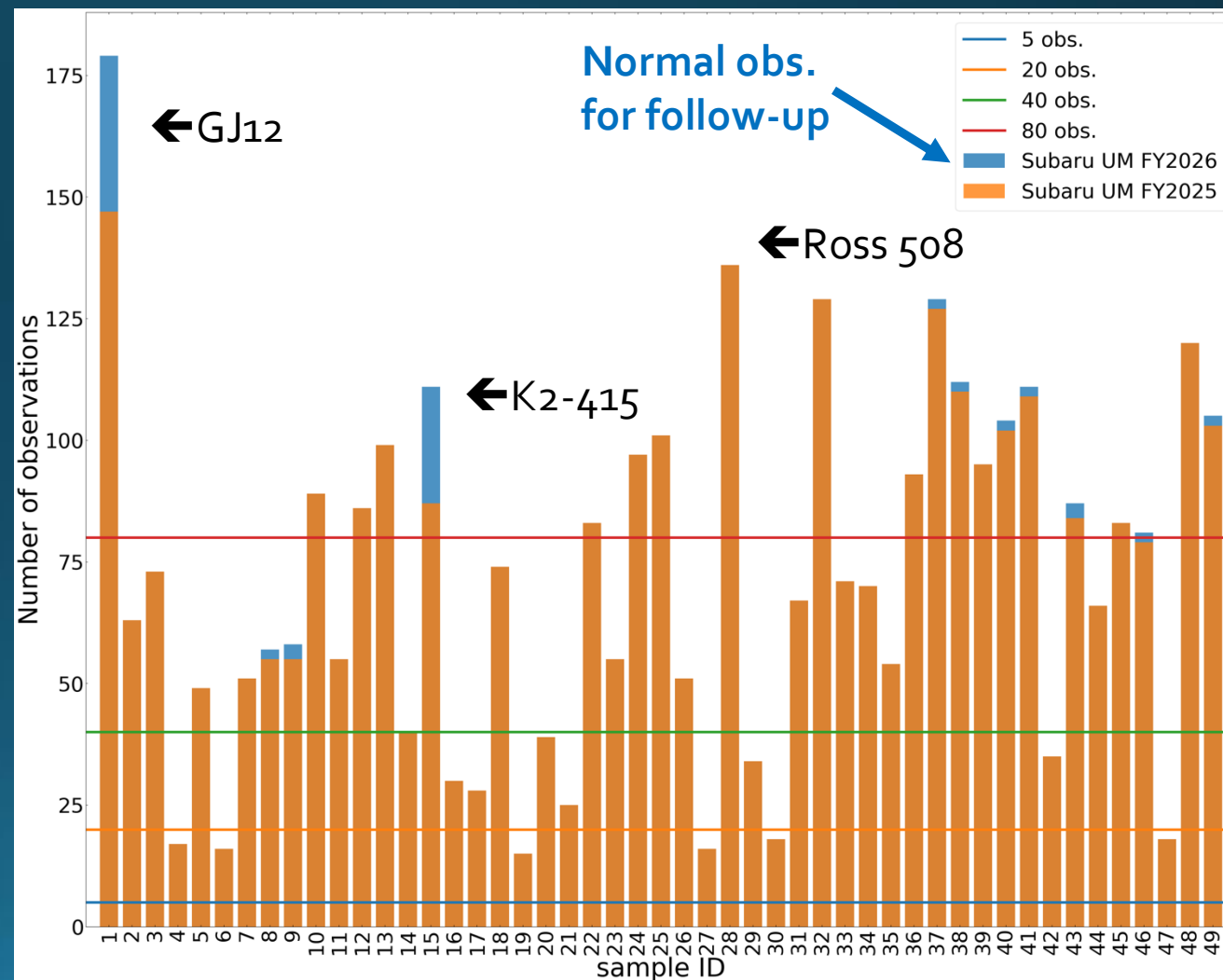


Completion rate = Observed nights / Allocated nights

Number of observations for each target

- Monitoring observations were carried out according to several criteria with levels of priority (screening, variability check, monitor, intensive follow-up).
- The numbers of observations for monitoring stars are shown on the right figure.
- The numbers of key stars are listed in the table below.

Number of observations	Number of stars
≥ 5	84
≥ 20	43
≥ 40	37
≥ 80	20

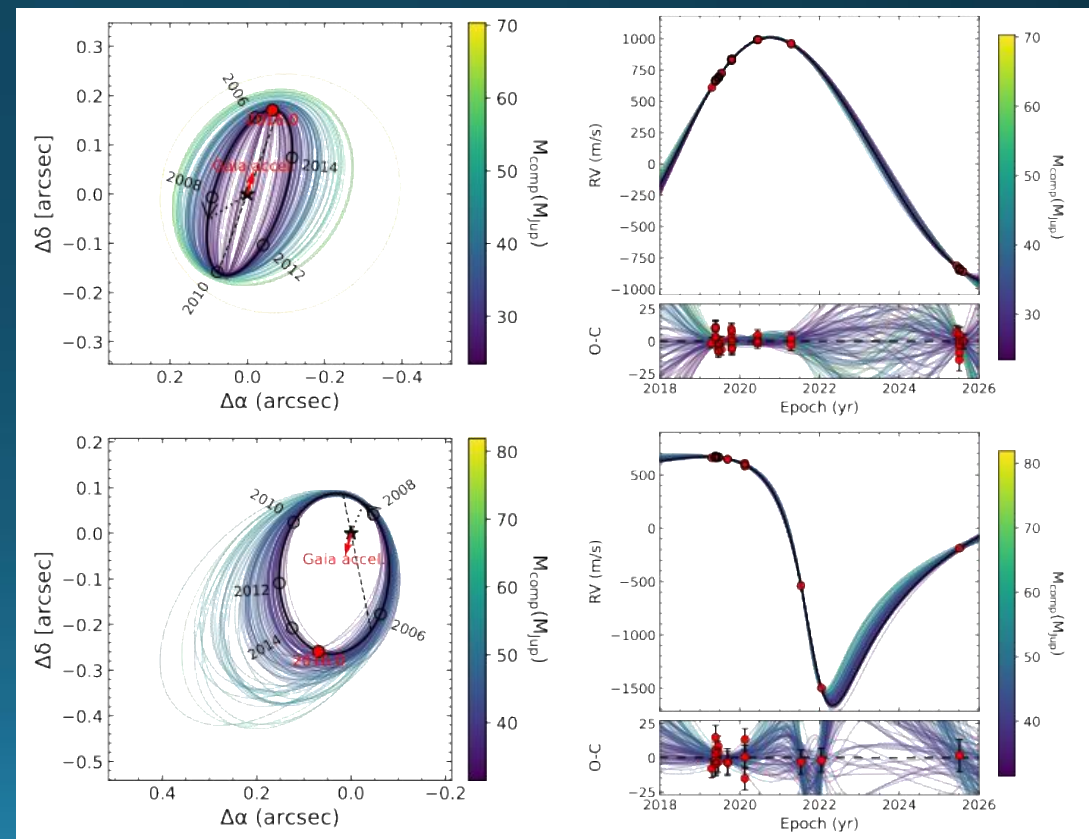


Discovery of Brown Dwarfs around late-M dwarfs

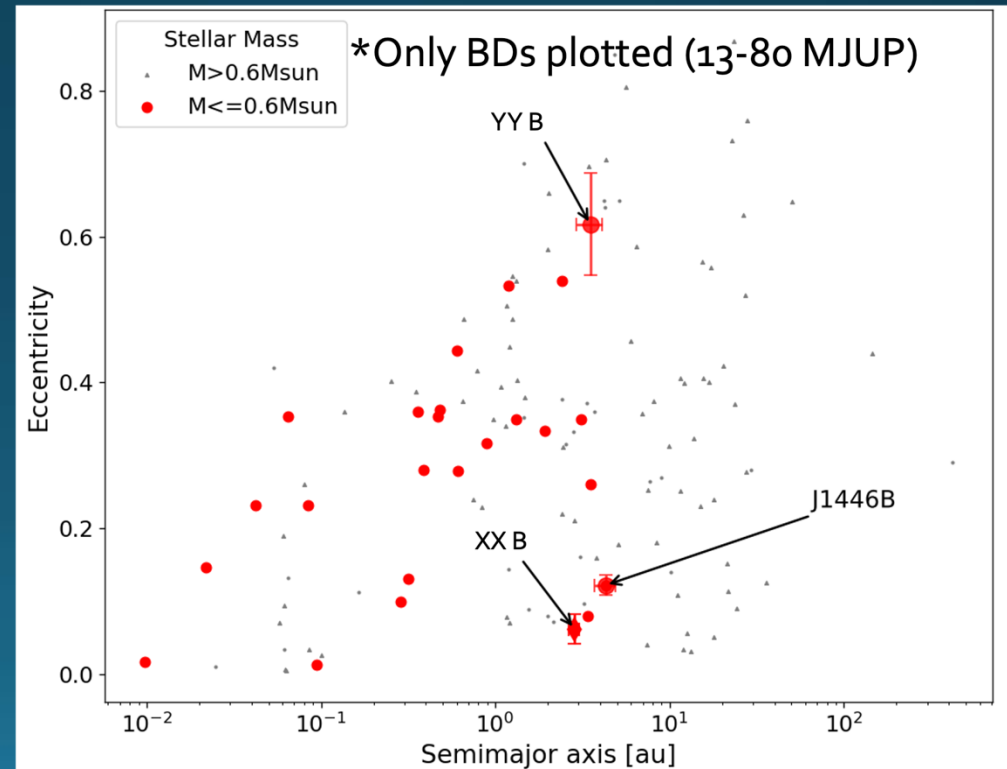
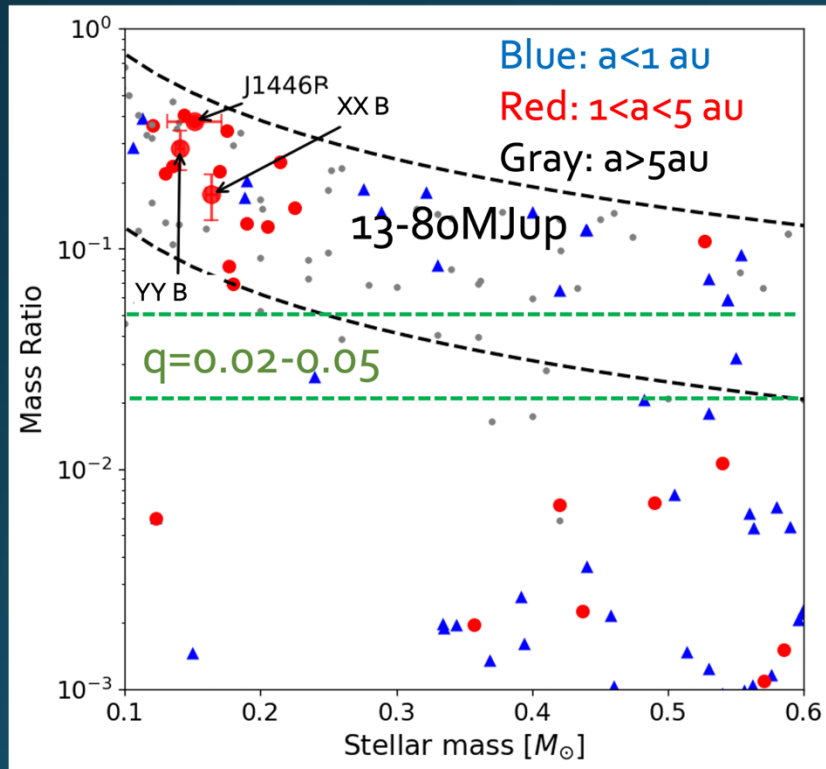
- A joint analysis of RVs taken with IRD and Gaia astrometry revealed brown dwarf companions around late-M dwarfs
- Imaging observation detect no companions (Uyama+ 2023 and This work)
→ Consistent with orbital solutions

Takarada et al. 2026 to be submitted

Staller Parameter	XX	YY
Spectral type	M4.5±0.6	M5±0.3
T_{eff} (K)	2895 ⁺²⁰ ₋₂₄	2948 ⁺¹² ₋₂₄
M_s ($M_{\odot}$)	0.1641 ± 0.0041	0.1408 ± 0.0034
R_s ($R_{\odot}$)	0.211 ^{+0.003} _{-0.002}	0.179 ^{+0.003} _{-0.001}
Planet Parameter	XX B	YY B
M_{sec} [M_{Jup}]	31.2 ^{+8.8} _{-5.0}	41.7 ⁺¹¹ _{-5.2}
a [AU]	2.87 ^{+0.25} _{-0.15}	3.49 ^{+0.65} _{-0.23}
Eccentricity	0.063 ^{+0.032} _{-0.015}	0.620 ^{+0.069} _{-0.033}
Mass ratio	0.181 ^{+0.050} _{-0.029}	0.283 ^{+0.075} _{-0.035}



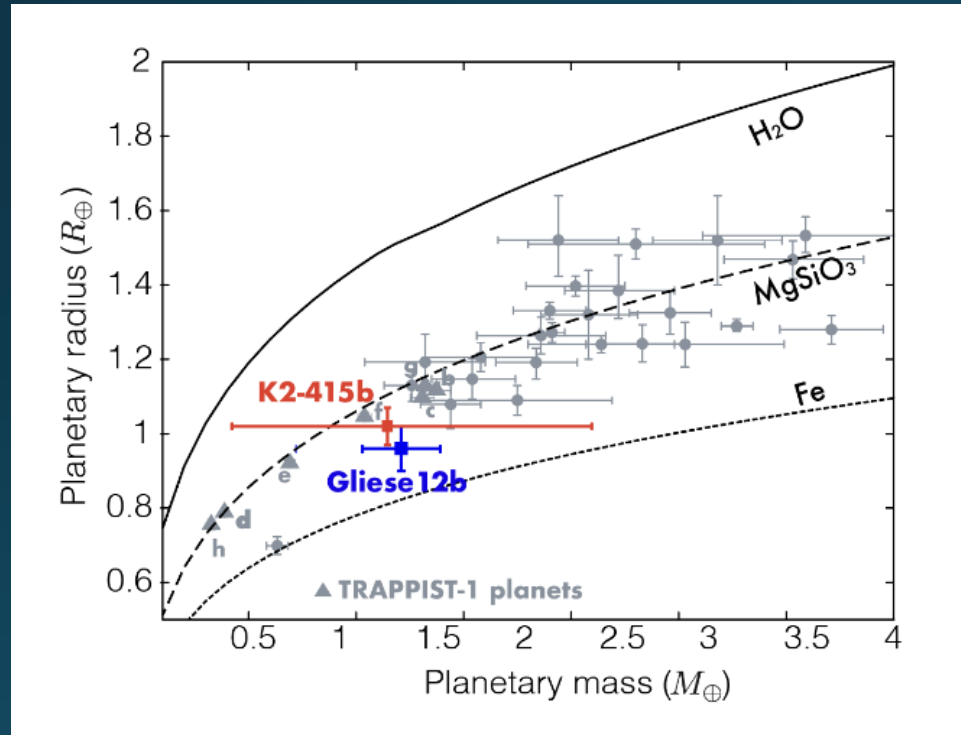
- 14 BDs are discovered around late-M dwarfs within the classical brown dwarf desert (1–5 au) suggested for solar-type stars (Left figure) → not desert for late-M stars
- The desert may depend on mass-ratio rather than absolute mass (Zhang 2025)
 - Consistent with a desert of mass-ratio ($q=0.02-0.05$) suggested for solar-type stars
- A broad eccentricity distribution is similar to that observed around solar-type stars (Right figure)



(J1446B
by Uyama+2025)

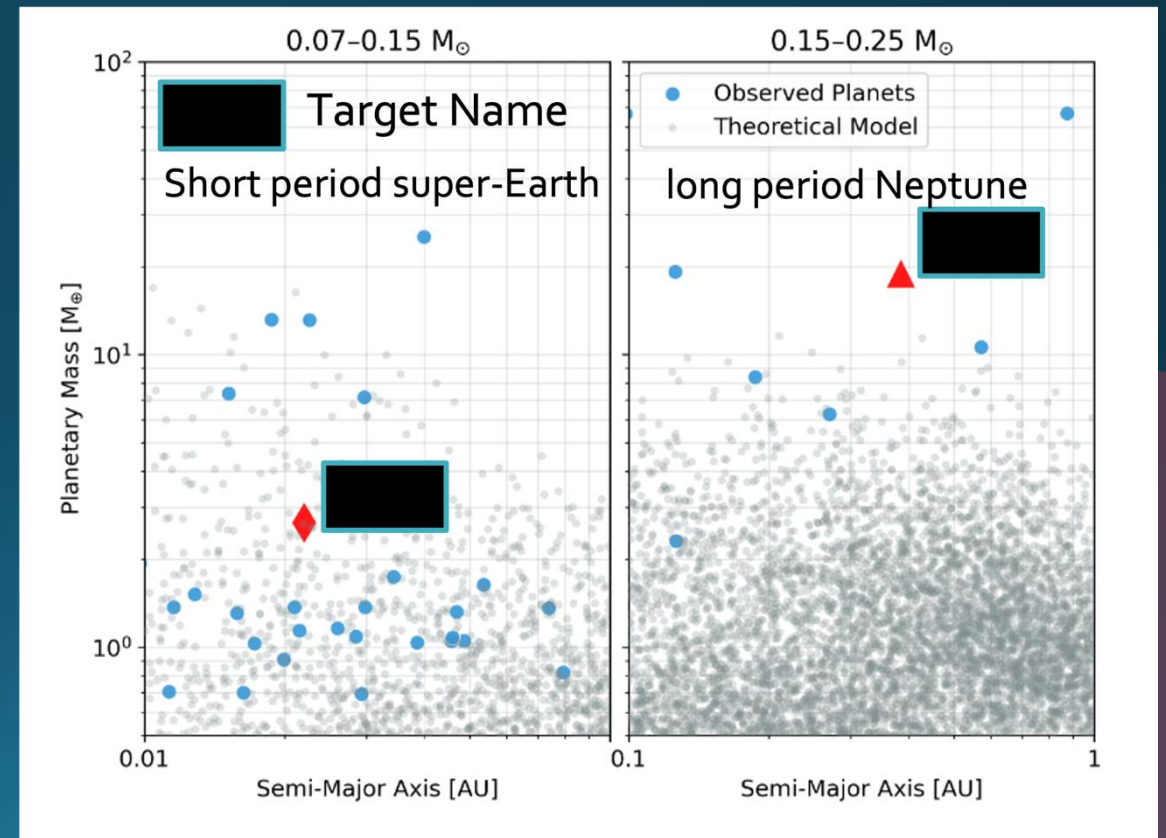
Follow-up observations for IRD-SSP planets and planet candidates

- Improving mass and eccentricity estimates for Earth-sized planets, GJ12b and K2-415b



w/ Subaru/IRD, Gemini/MAROON-X led by Kuzuhara (S25A & S25B, S26A accepted, S26B proposed)

- Confirming planetary candidates with unknown or challenging properties



w/ Gemini/MAROON-X led by Kotani (S26B proposed)

Papers in planning

- Magnetic activity of M dwarfs (activity indicator, line-profile analysis etc.)
- Binary study (orbital motion, dynamical mass, etc.) using FIM and RV data
- Atmospheric parameters and abundance analysis for IRD-SSP targets
- Development of calibration method for telluric lines using rapidly rotating stars taken with IRD
- Input catalog (target parameters, stellar activity, H α intensity etc.)
- Spectral library (N1R spectra of IRD-SSP targets)
- RV data release paper (DR₁, DR₂)
- Follow-up works on known planet-host stars
- Statistical analysis (occurrence rate, distribution of planets etc.) for IRD-SSP targets
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