

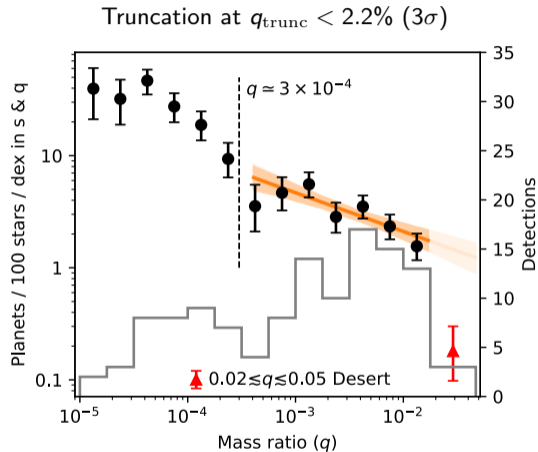
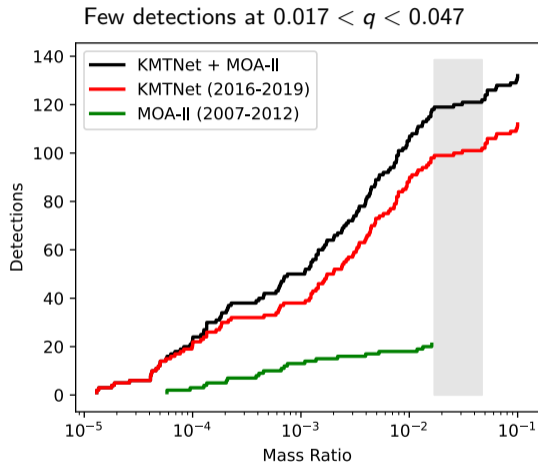
Giant Planets Grow to at Most 2% of Host Mass via Core Accretion

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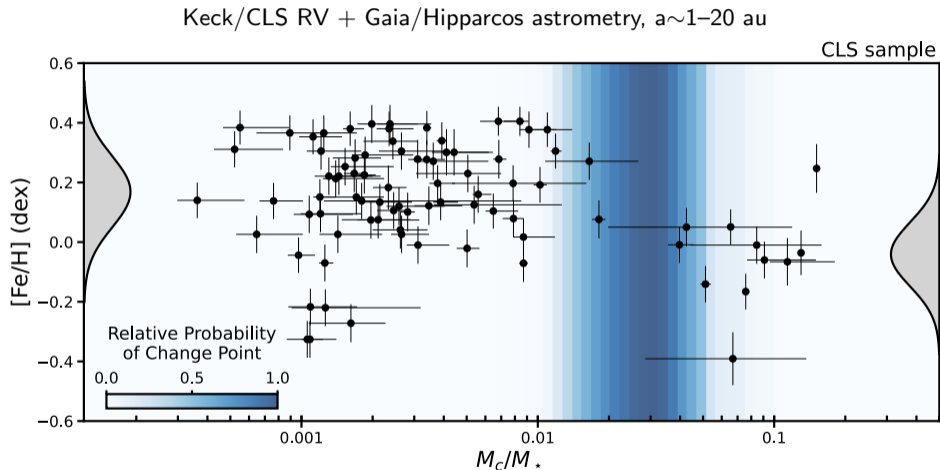
On the Shoulders of Giants
Turin, Italy — March 25–27, 2026

Microlensing: A Mass-Ratio Desert at $q \simeq 2\text{--}5\%$



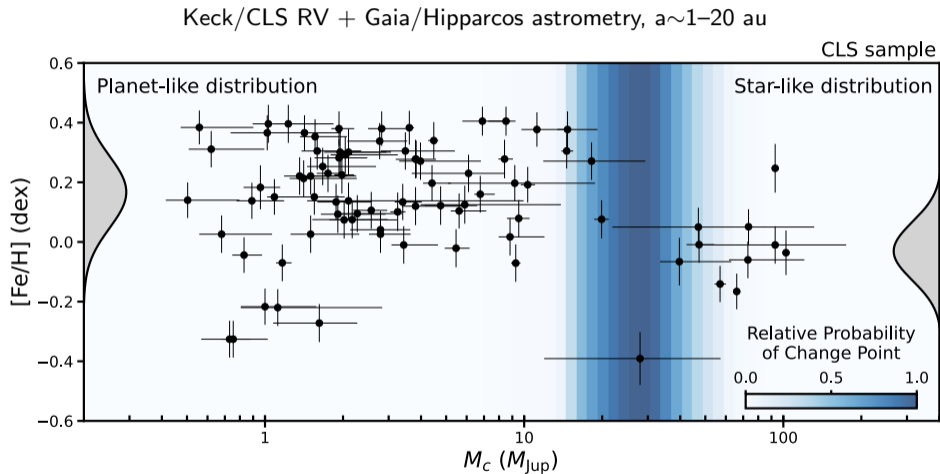
K. Zhang (2025; ApJL 995, L55): The Brown-dwarf Desert Persists as a Mass-ratio Desert around Low-mass Stars

Below $q \simeq 2\%$, Companions Prefer Metal-Rich Hosts



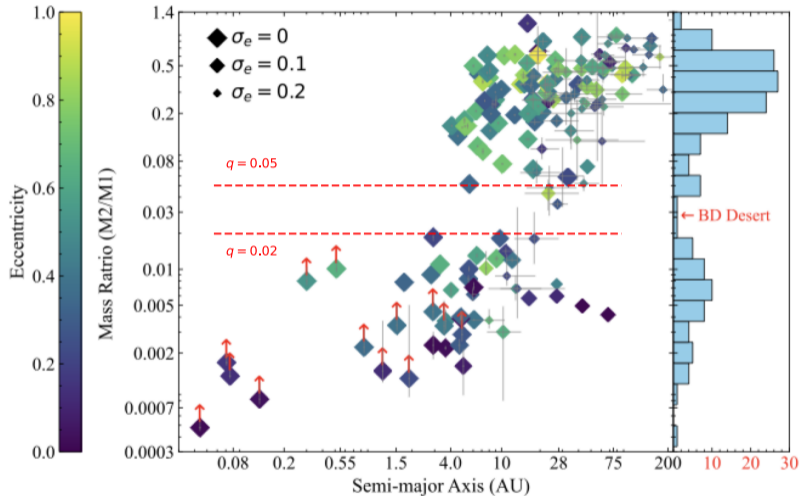
S. Giacalone et al. (2026; AJ 171 75)

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S. Giacalone et al. (2026; AJ 171:75)

A Larger Sample of RV + Astrometry: Similar Desert out to ~ 20 au



Q. An et al. (2025; ApJS 280:61)

Microlensing Desert Companions Likely Orbit White Dwarfs

	$M_{\text{host}} (M_{\odot})$	$M_p (M_J)$	$a_{\text{proj}} (\text{au})$	$q (\%)$
OGLE-2016-BLG-1635L b	$0.43^{+0.33}_{-0.33}$	11.5	1.3 / 3.8	2.5
MOA-2011-BLG-322L b	$0.39^{+0.45}_{-0.19}$	11.6	4.3	2.8
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If we assume $\sim 15\%$ of lenses are WDs*, we expect **around 3** planets to shift into this desert!

* Assuming WDs and MS stars are equally likely to host giant planets.

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Example: KMT-2020-BLG-0414Lbc (K. Zhang et al. 2024, Nat. Astron. 8, 1575)

$0.5 M_{\odot}$ WD hosts a $1.9 M_{\oplus}$ planet **and** a $27 M_J$ BD ($q \approx 4.6\%$).

Progenitor $\gtrsim 1.3 M_{\odot} \Rightarrow q \lesssim 2\%$: the BD most likely **formed as a planet** i.e., via core accretion.

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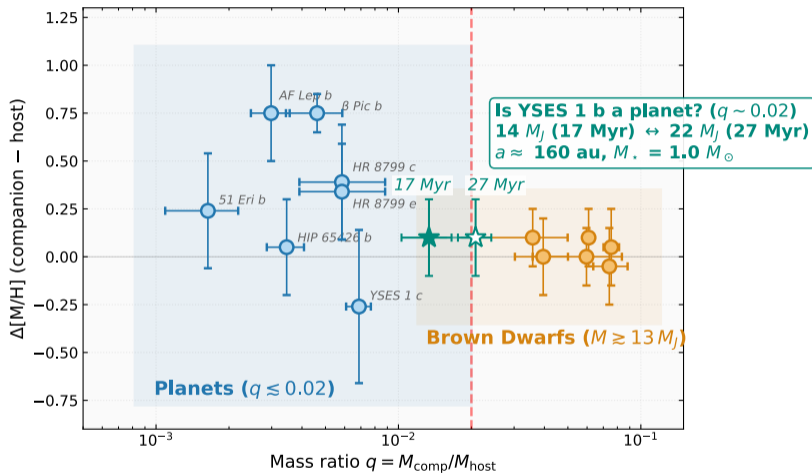
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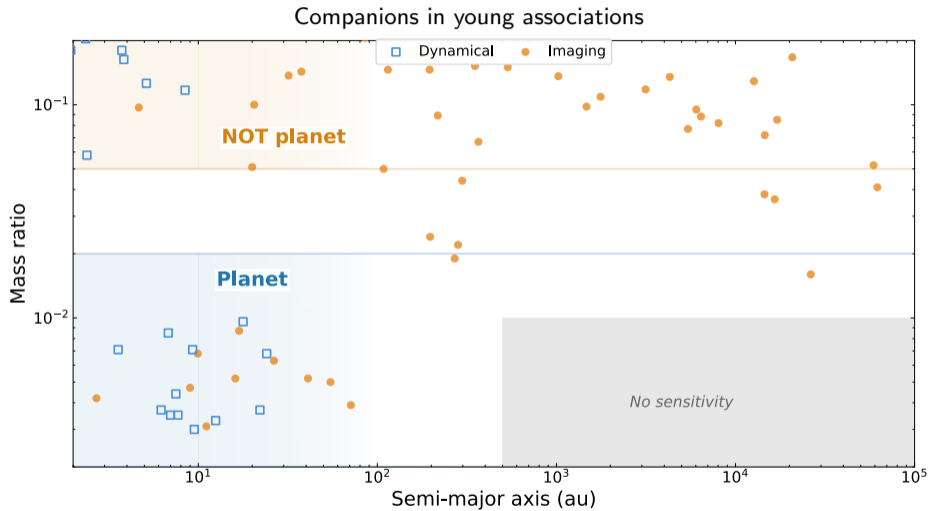
If these orbit WDs, the desert around MS stars is even drier.

Below $q \simeq 2\%$, Companions Are Metal-Enriched Compared to Host



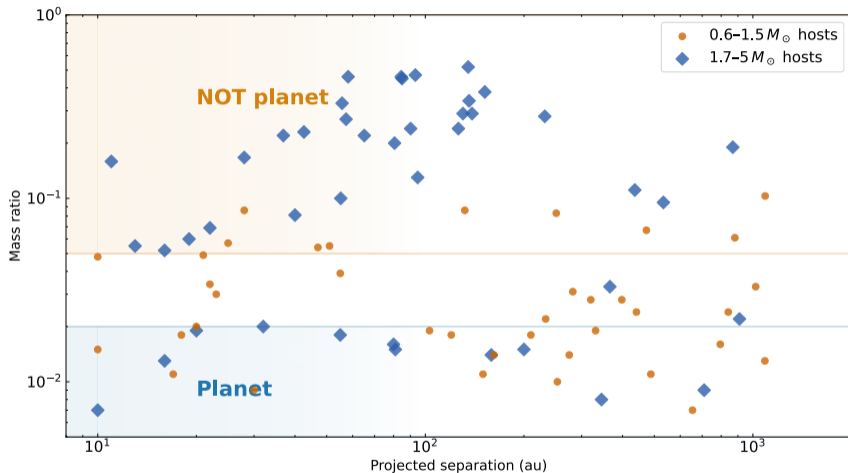
Data from J. Wang (2025; ApJ 981, 138), replotted in mass ratio

Direct Imaging: Desert beyond ~ 20 au?



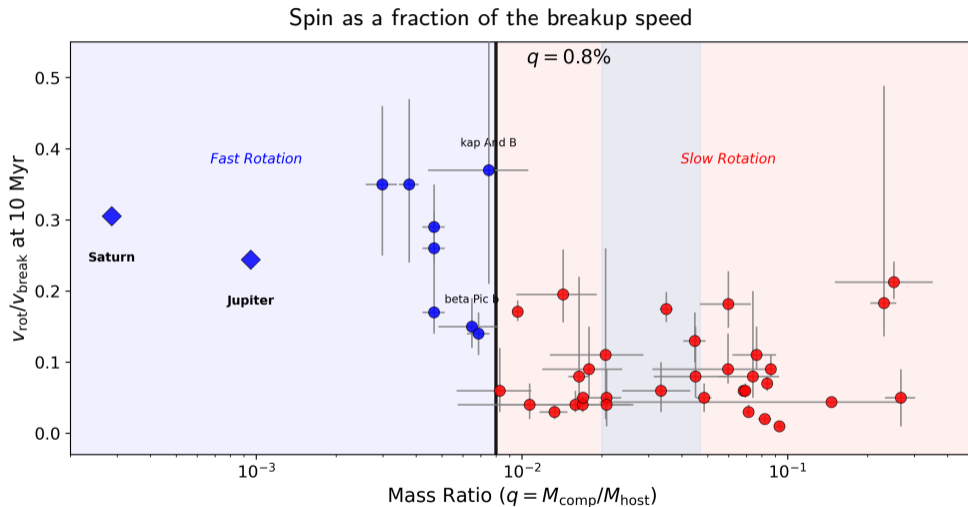
Plotted from table data in R. Gratton et al. (2024; A&A 685, A119)

Direct Imaging: Universal $q \simeq 2-5\%$ Desert for $0.6-5 M_{\odot}$ Hosts



Plotted from data in G. Duchêne et al. (2023; MNRAS 519, 778)

Planet vs. Brown Dwarf: Rotation Dichotomy at $q \simeq 0.8\%$?



Reproduced from C.-C. Hsu et al. (2026; AJ 171:224), Figure 6 lower panel

K. Zhang (2025): *The Brown-dwarf Desert Persists as a Mass-ratio Desert around Low-mass Stars*

Abstract: [... We] identify a companion mass-ratio desert at $0.02 \lesssim q \lesssim 0.05$ and [...] a **statistically significant truncation** to the giant-planet mass-ratio distribution at $q \simeq 0.02$ [...] Our analysis furthers the hypothesis that the brown-dwarf desert is fundamentally a feature in the mass ratio, separating distinct populations of planetary and nonplanetary companions that are likely formed via core accretion and gravitational instability, [...] with **planets growing to a maximum of $\sim 2\%$ of their host masses.**

- **Defining planets by the mass ratio:** $q \lesssim 0.02$
- **Defining brown dwarfs by the mass:** $13 \lesssim M \lesssim 80 M_J$
- $20 M_J$ around $2 M_\odot$: both a **planet** by formation ($q = 0.01$) and a **BD**
- $10 M_J$ around $0.1 M_\odot$: neither a **planet** ($q = 0.1$) nor a **BD**. Stellar binary?