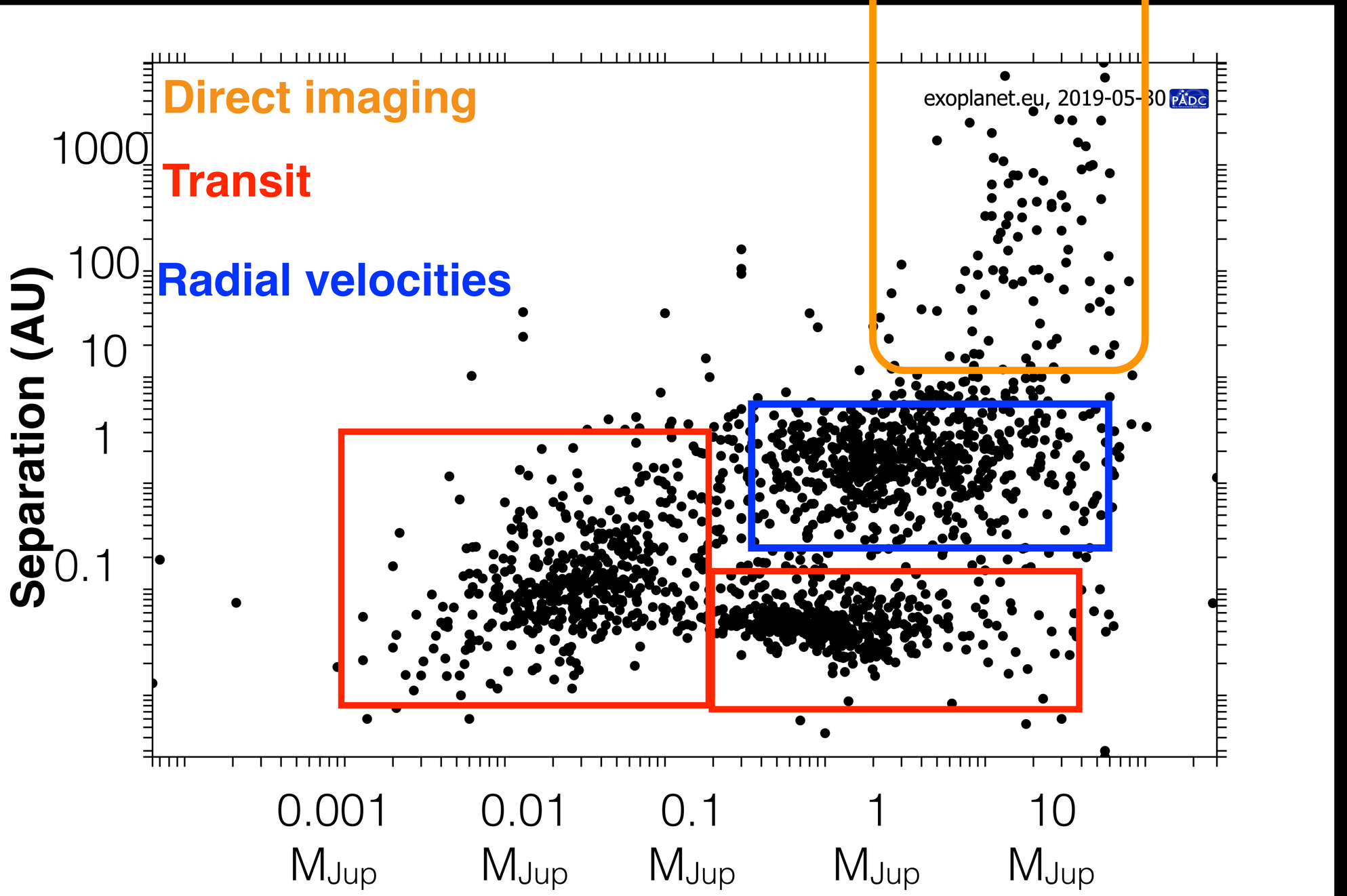
Lucas Granito

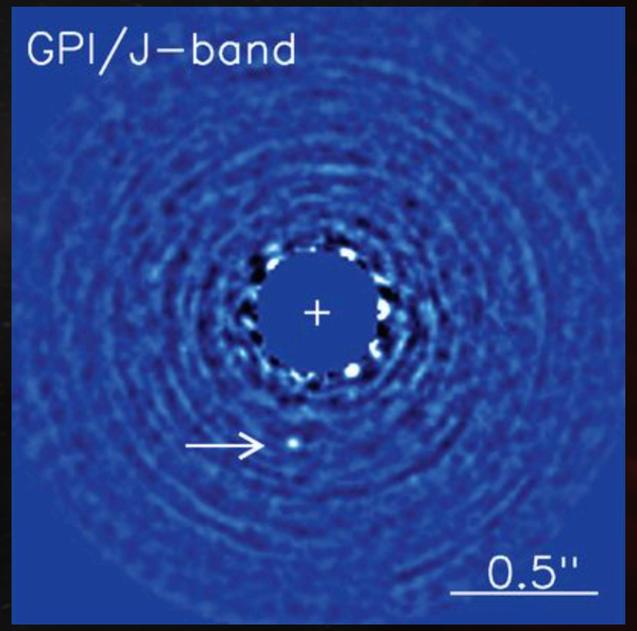
Constraining the distribution of giant planet on wide orbits from a compilation of direct imaging surveys

Frédérique Baron, Ph.D
Université de Montréal—iREx

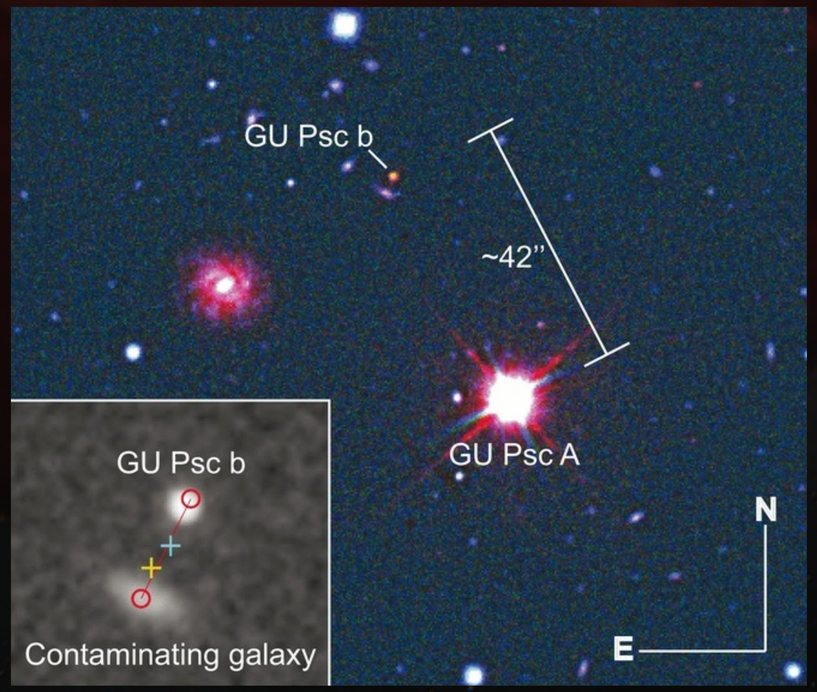
CASCA2019
18 juin 2019


Direct imaging
Transit
Radial velocities
exoplanet.eu, 2019-05-30
PADC
Separation (AU)
1000
100
10
1
0.1
0.001 MJup
0.01 MJup
0.1 MJup
1 MJup
10 MJup

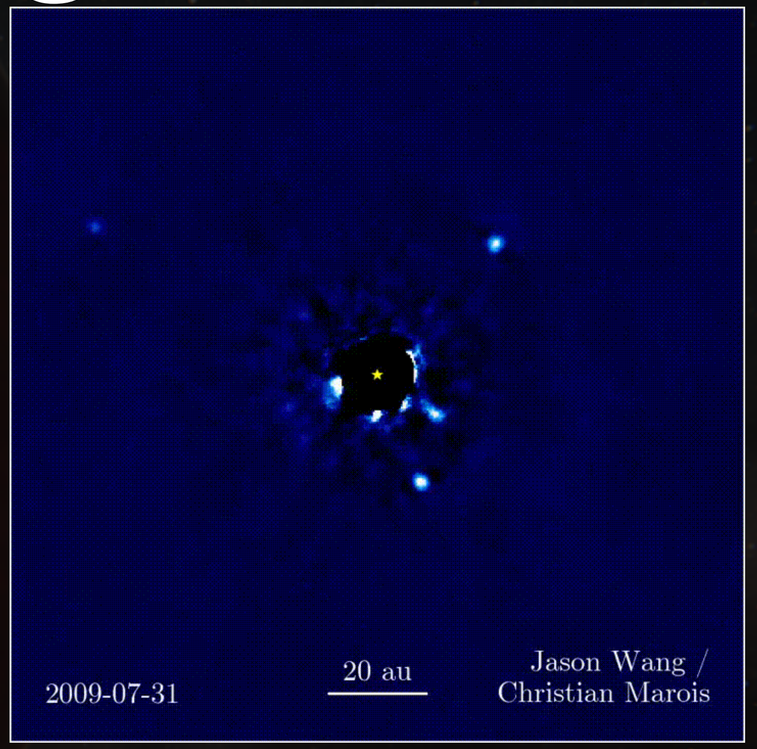
Direct Imaging



Macintosh et al 2015



Naud et al. 2014



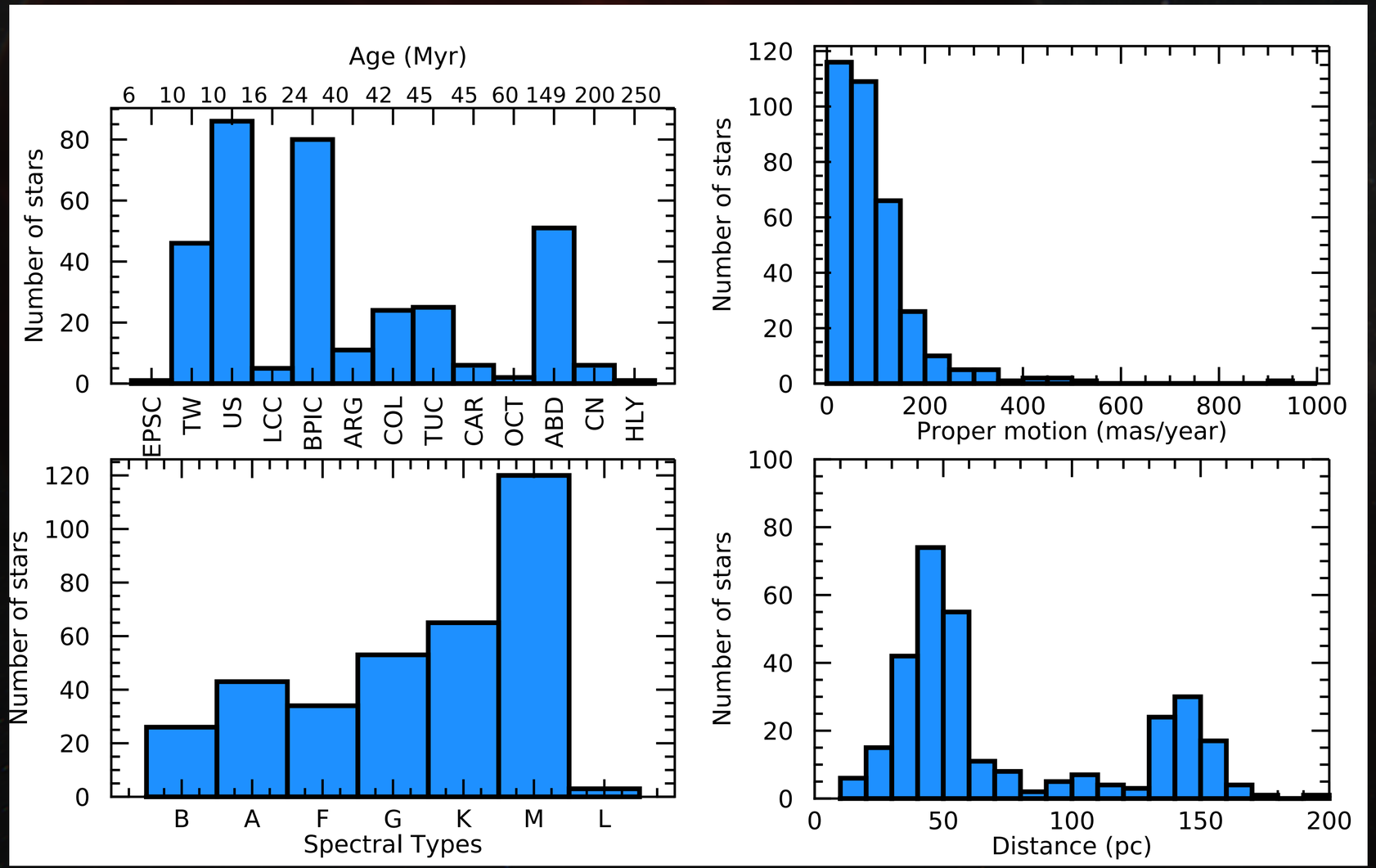
Sample

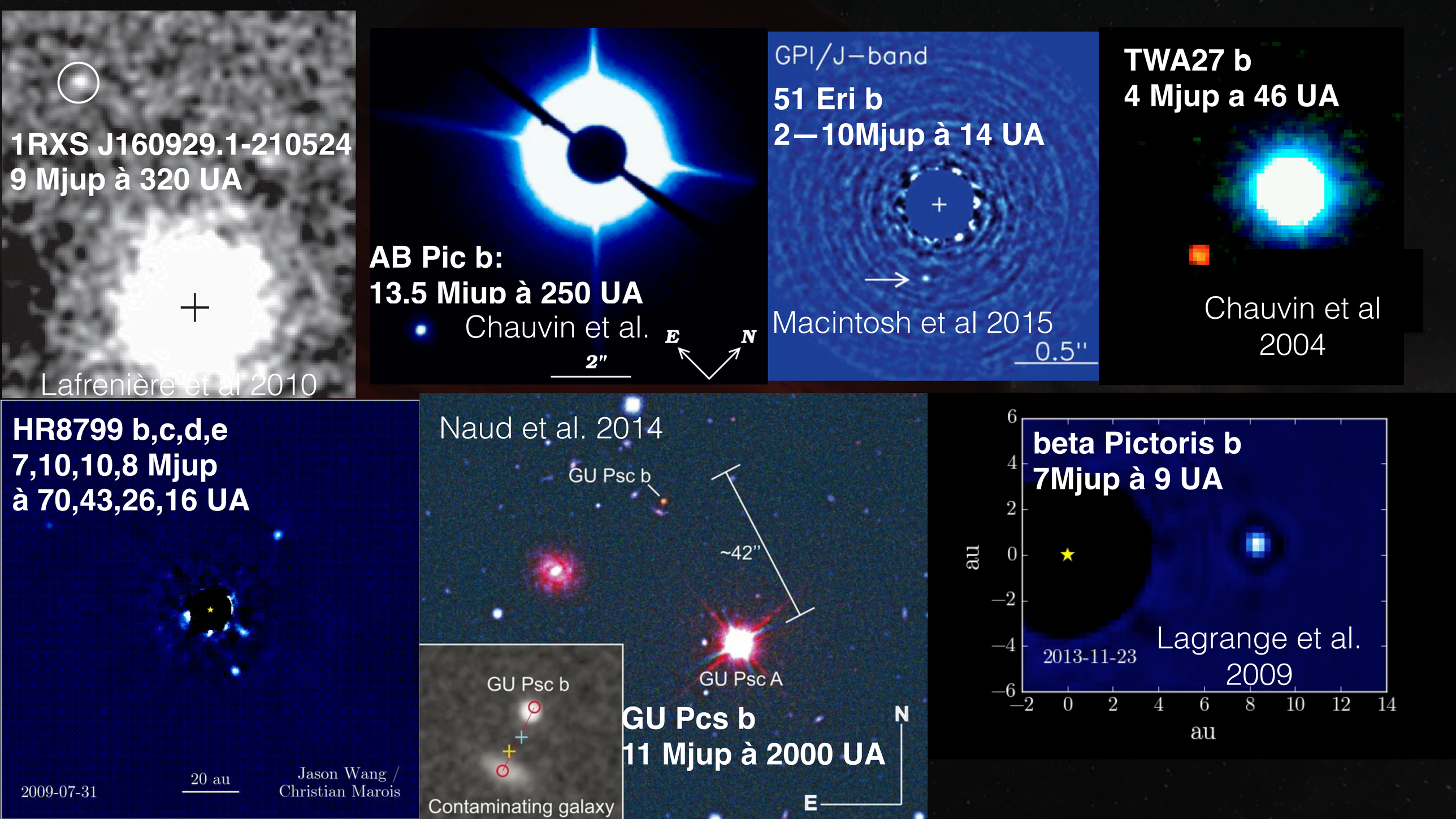
Upper Scorpius from Lafrenière et al 2014 → **High contrast imaging far away stars**

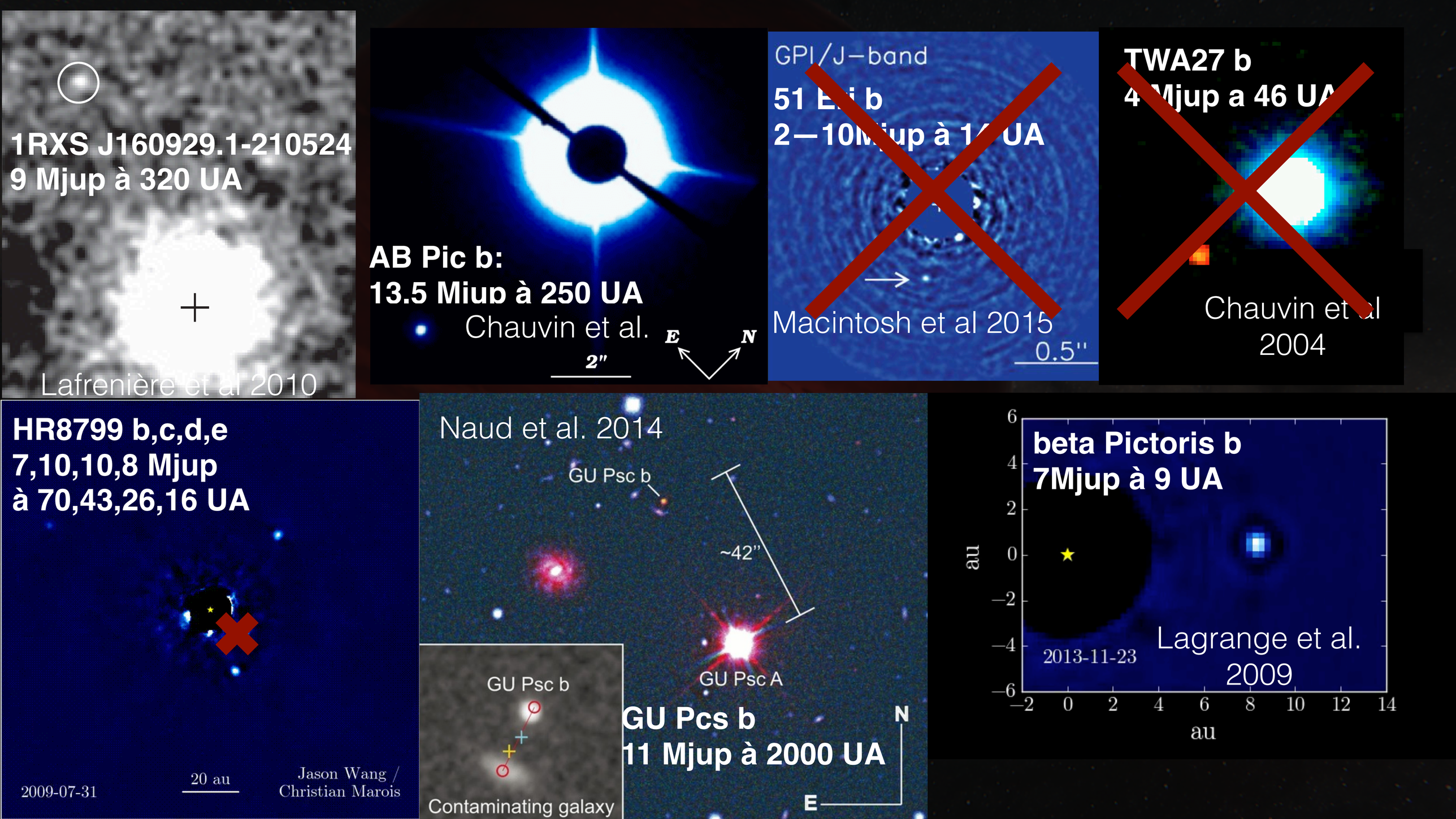
PSYM-WIDE from Naud et al. 2017 → **Seeing-limited wide orbits**

WEIRD! from Baron et al. 2018 → **Seeing-limited wide orbits**

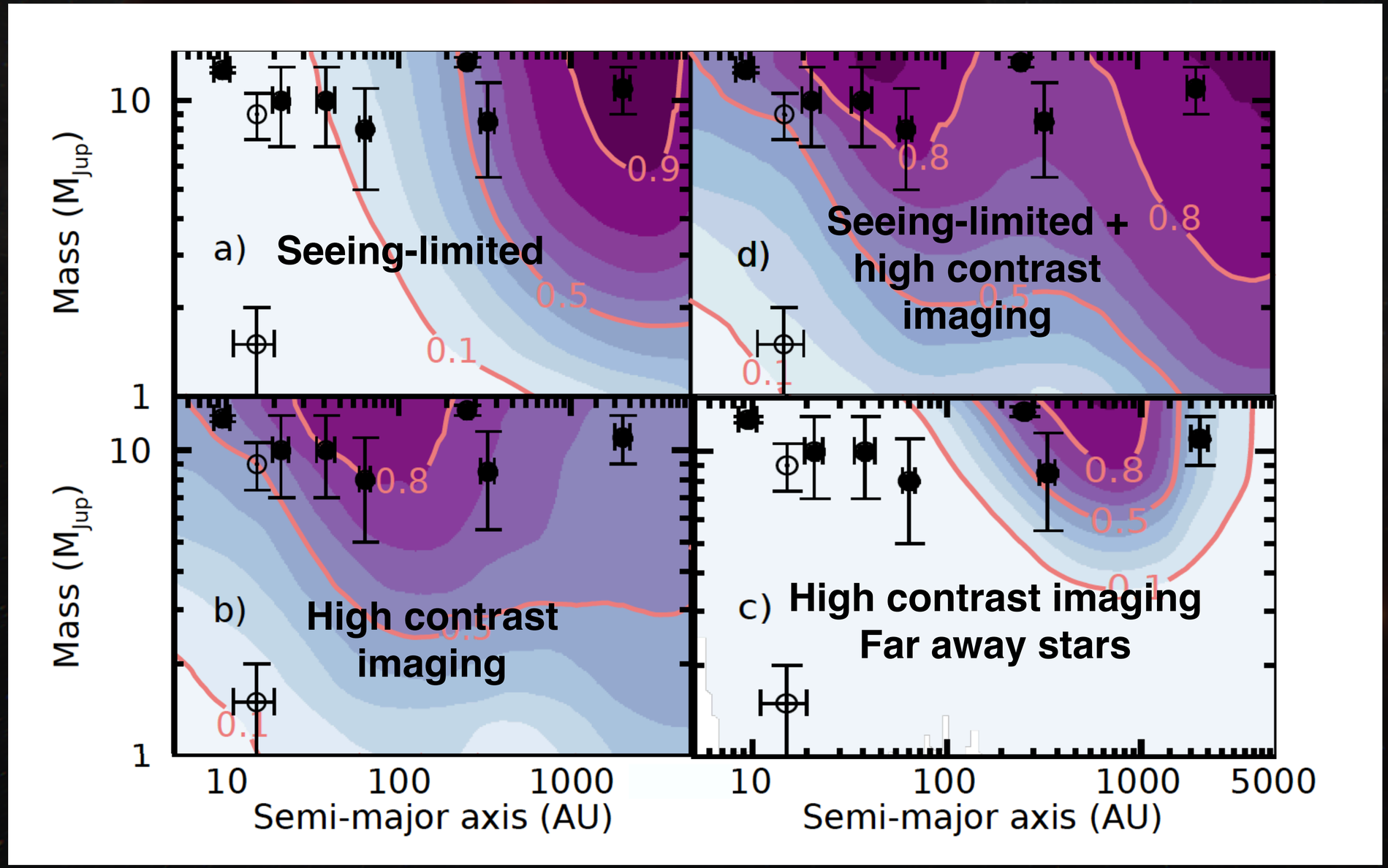
Sample


Age (Myr)
6 10 10 16 24 40 42 45 45 60 149 200 250
Number of stars
0 20 40 60 80
EPSC TW US LCC BPIC ARG COL TUC CAR OCT ABD CN HLY
Number of stars
0 20 40 60 80 100 120
Proper motion (mas/year)
0 200 400 600 800 1000
Number of stars
0 20 40 60 80 100 120
B A F G K M L
Spectral Types
Number of stars
0 20 40 60 80 100
Distance (pc)
0 50 100 150 200


1RXS J160929.1-210524
9 Mjup à 320 UA
Lafrenière et al 2010
AB Pic b:
13.5 Miup à 250 UA
Chauvin et al.
E
N
2"
GPI/J−band
51 Eri b
2—10Mjup à 14 UA
Macintosh et al 2015
0.5''
TWA27 b
4 Mjup a 46 UA
Chauvin et al
2004
HR8799 b,c,d,e
7,10,10,8 Mjup
à 70,43,26,16 UA
2009-07-31
20 au
Jason Wang /
Christian Marois
Naud et al. 2014
GU Psc b
~42"
GU Psc A
GU Psc b
Contaminating galaxy
GU Pcs b
11 Mjup à 2000 UA
N
E
beta Pictoris b
7Mjup à 9 UA
au
2013-11-23
Lagrange et al.
2009


1RXS J160929.1-210524
9 Mjup à 320 UA
Lafrenière et al 2010
AB Pic b:
13.5 Miup à 250 UA
Chauvin et al.
E
N
2"
GPI/J-band
51 E.i b
2—10Mjup à 1. UA
Macintosh et al 2015
0.5''
TWA27 b
4 Mjup a 46 UA
Chauvin et al
2004
HR8799 b,c,d,e
7,10,10,8 Mjup
à 70,43,26,16 UA
2009-07-31
20 au
Jason Wang /
Christian Marois
Naud et al. 2014
GU Psc b
~42"
GU Psc A
GU Psc b
Contaminating galaxy
GU Pcs b
11 Mjup à 2000 UA
N
E
beta Pictoris b
7Mjup à 9 UA
au
au
2013-11-23
Lagrange et al.
2009

Contrast Curves



Constraining the **distribution** of giant planets on wide orbits

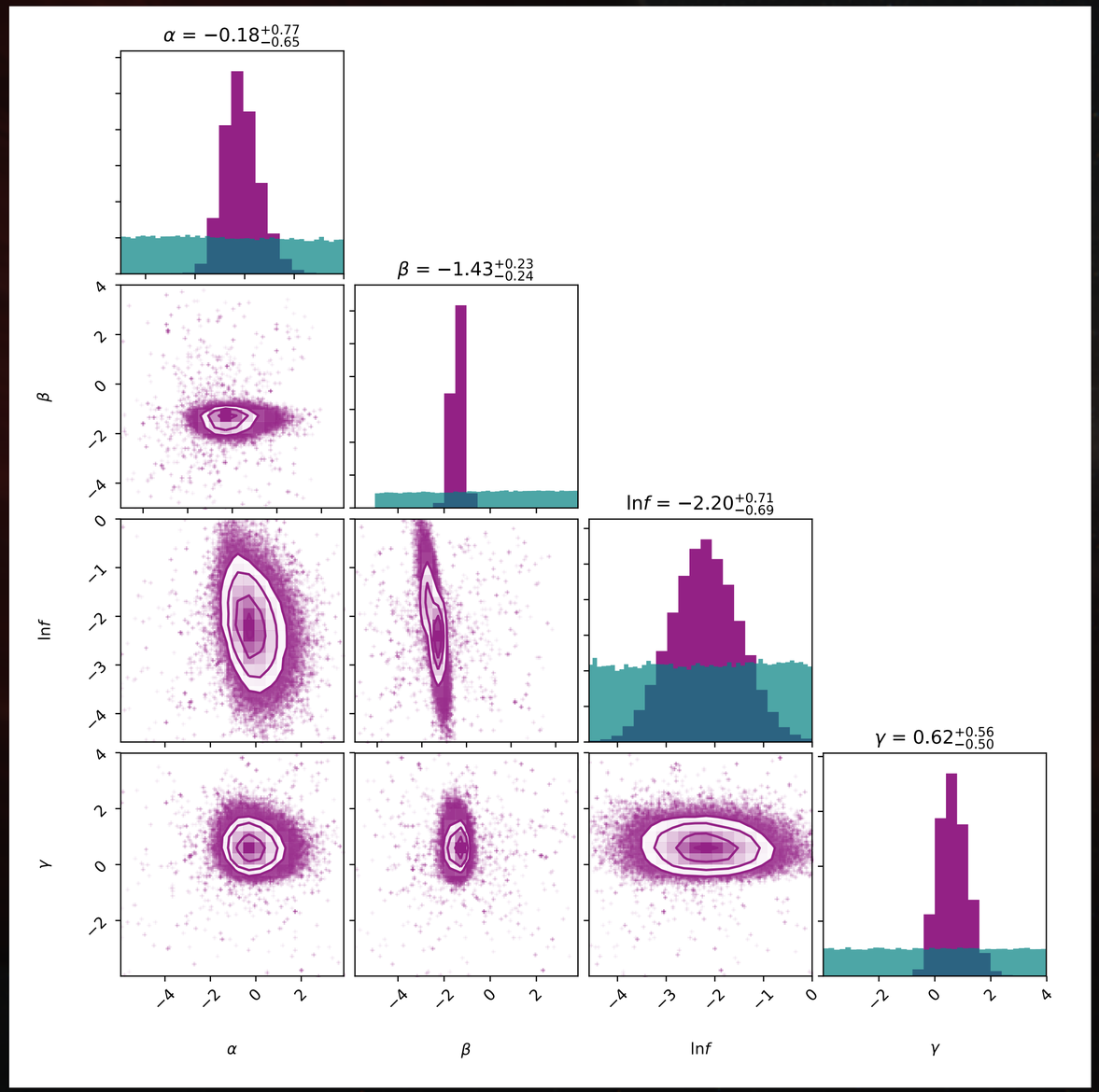
- Assuming that $\mathrm{d}^2 n \propto f M^{\alpha} a^{\beta} M_{\star}^{\gamma} \mathrm{d}M \mathrm{d}a$
- Goal : constraint the value of α, β, γ, f
- According to the Bayes theorem,

$$\mathscr{L}(\{d_{k,is}\} \mid \{\alpha, \beta, \gamma, f\}) = \prod_{k=0}^{N} \prod_{i,s} e^{-C_{k,is} n_{is}} (C_{k,is} n_{is})^{d_{k,is}}$$

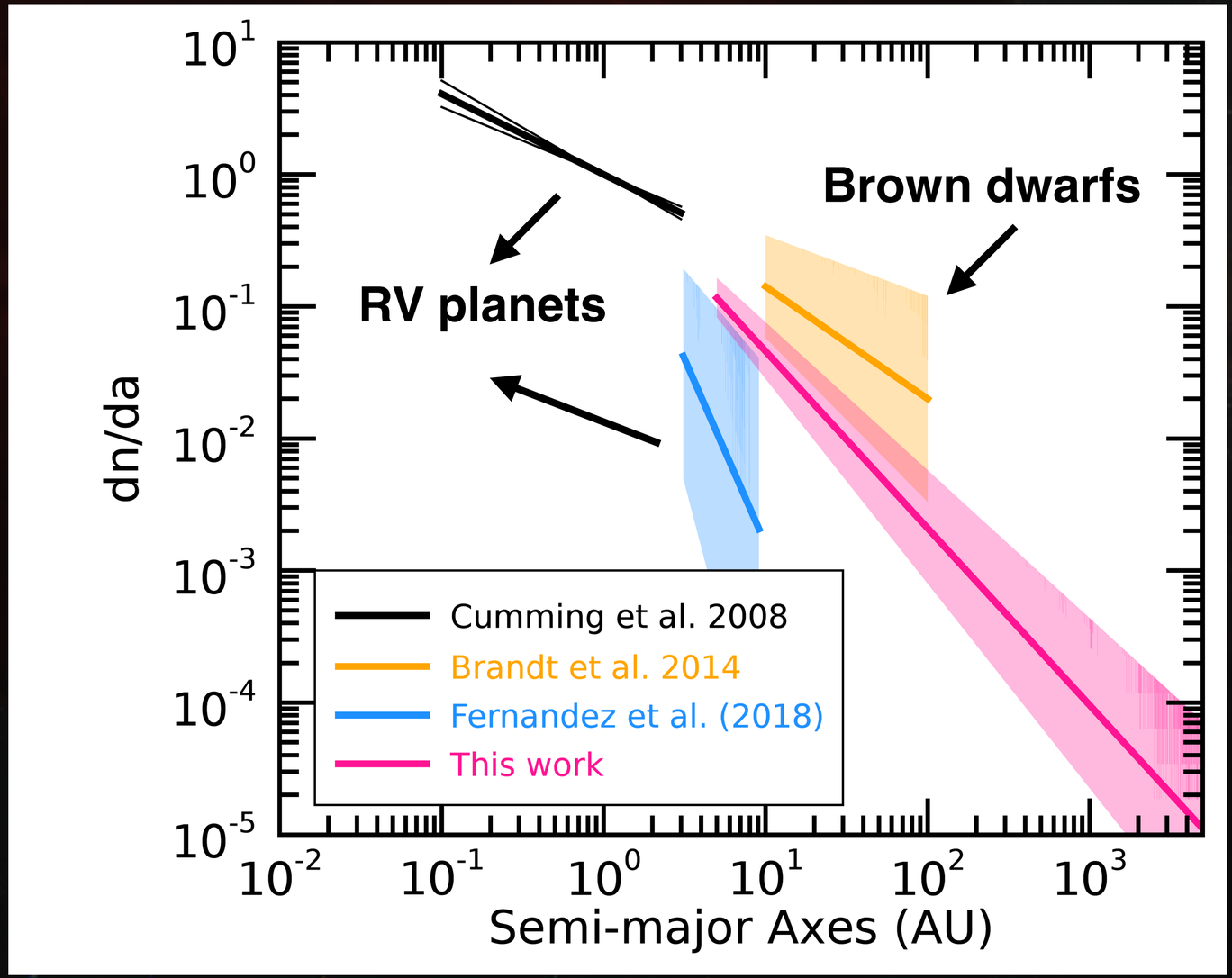
$$p(model \mid d_k) = \frac{\mathscr{L}(\{d_k\} \mid model) p(model)}{\int \mathscr{L}(\{d_k\} \mid model) p(model) \mathrm{d}model}$$

Results $d^2n \propto f M_\star^\gamma M^\alpha a^\beta \mathrm{d}M\mathrm{d}a$

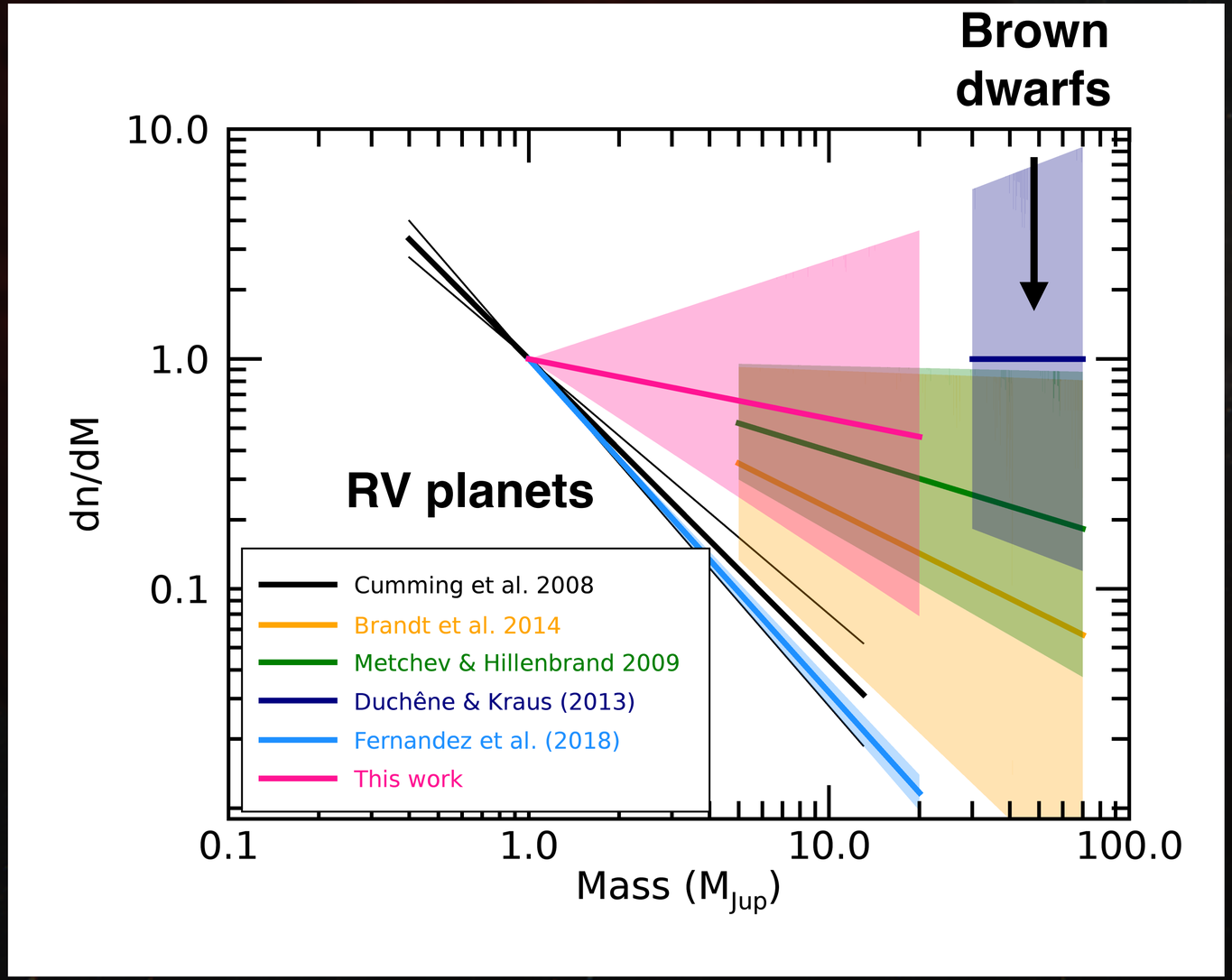
- **More companions when**
  - **Companion's mass is smaller**
  - **Orbit is shorter**
  - **Host star is massive**



Semi-major axis distribution



Mass distribution



Conclusion

- More companions when
  - Companion's mass is **smaller**
  - Orbit is **shorter**
  - Host star is **massive**

Distributions indicate that we might be seeing the **end** tail **distribution** of the **brown dwarfs** instead of the rapidly growing distribution of planets.