Doppler surveys: Super-Earths and Neptune-type planets

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The HARPS search for southern extra-solar planets XXXIV . Occurence, mass distribution and orbital properties of Super-Earths and Neptune-mass planets.

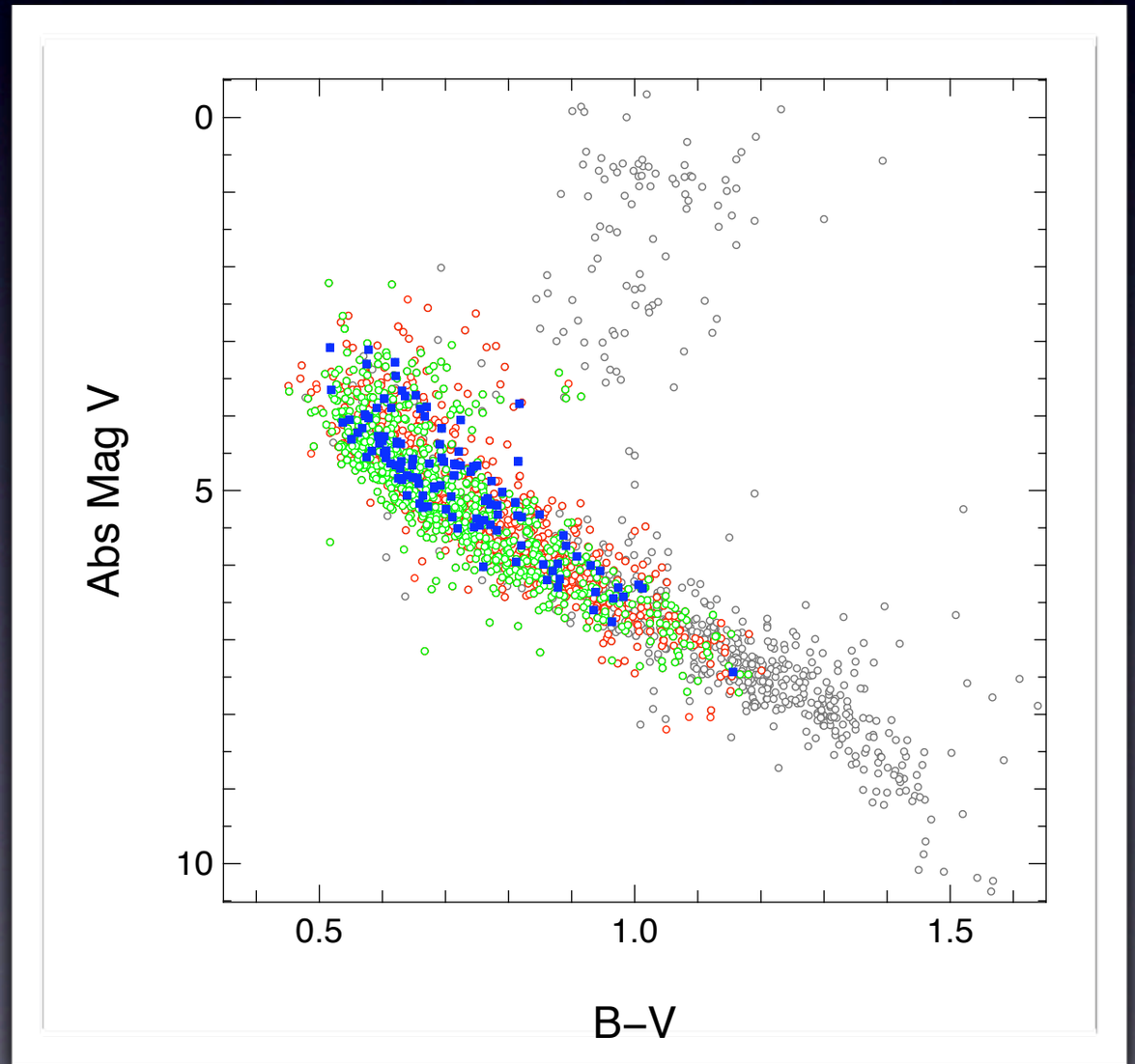
M.Mayor, M.Marmier,C.Lovis et al. 2011
Astroph. Tuesday Sept 13th

Including the announcement of 37 new planets
of which 15 Super-Earths

+ in press 5 planets Pepe et al.2011
+ in press 5 planets Dumusque et al. 2011
+ in prep 8 planets (CORALIE) Marmier et al. 2011
>>>> 55 NEW PLANETS (19 Super-earths)

CORALIE volume limited sample
+ constraints Log R'HK < -4.75 (F,G) ; -4.70 (K) , no binary
822 stars (1998 to present) .... Gaseous giant planets ,long P

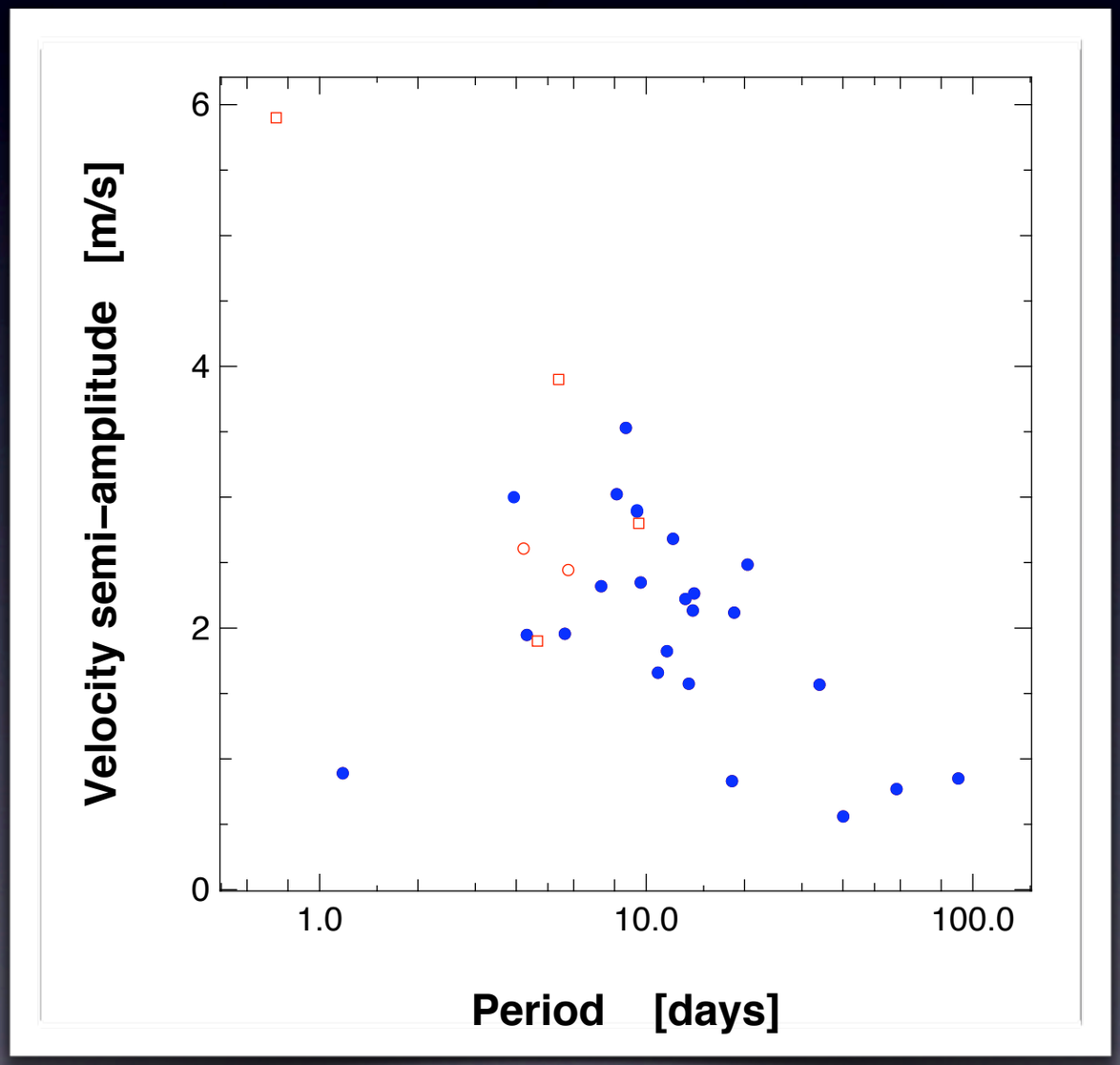
HARPS subsample , 376 stars (2003 to present)
measurement precision ≃ 0.5 m/s
..... Super-Earths + Neptune-mass planets



The radial velocity precision : a key parameter to detect Super-Earths (1-10 Earth-masses)

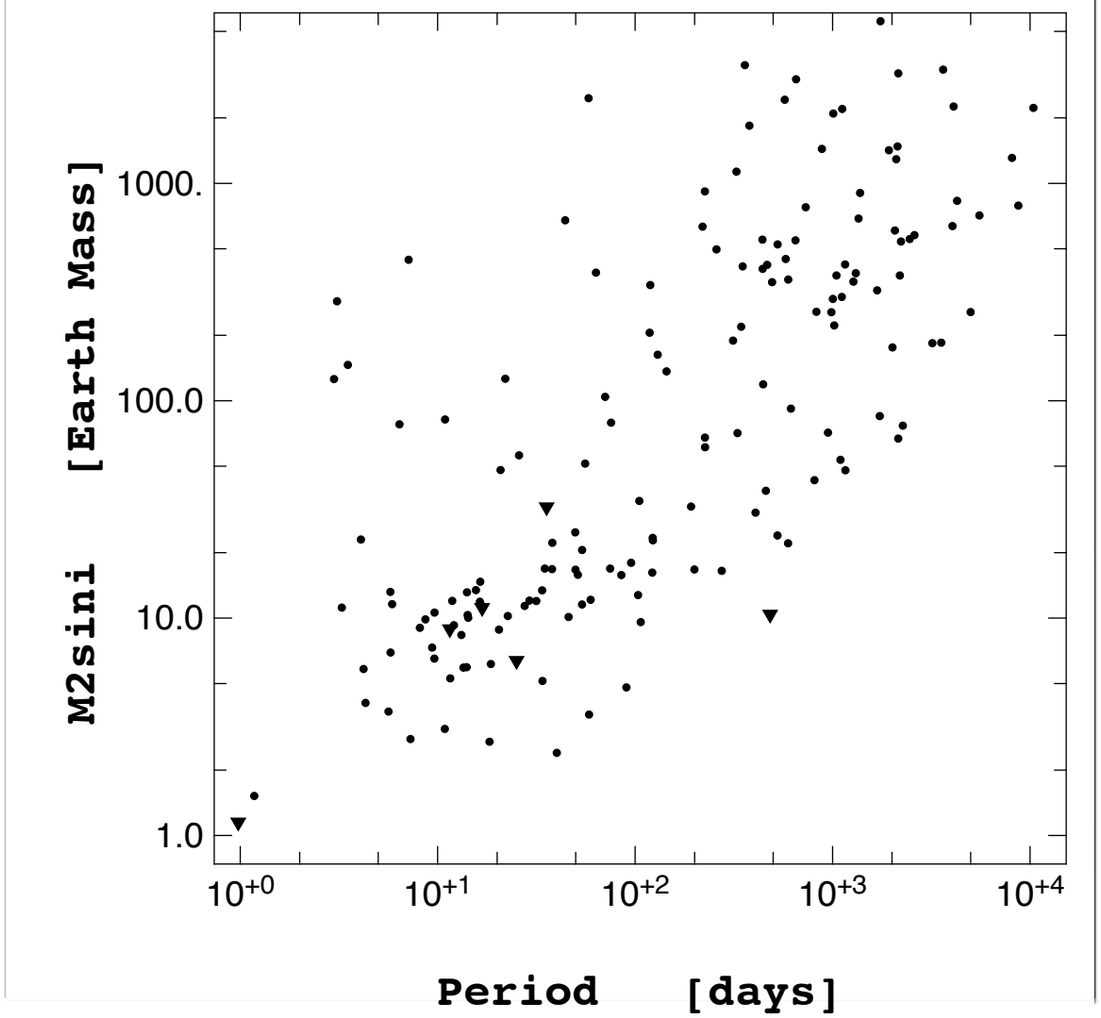
HARPS Super-Earths

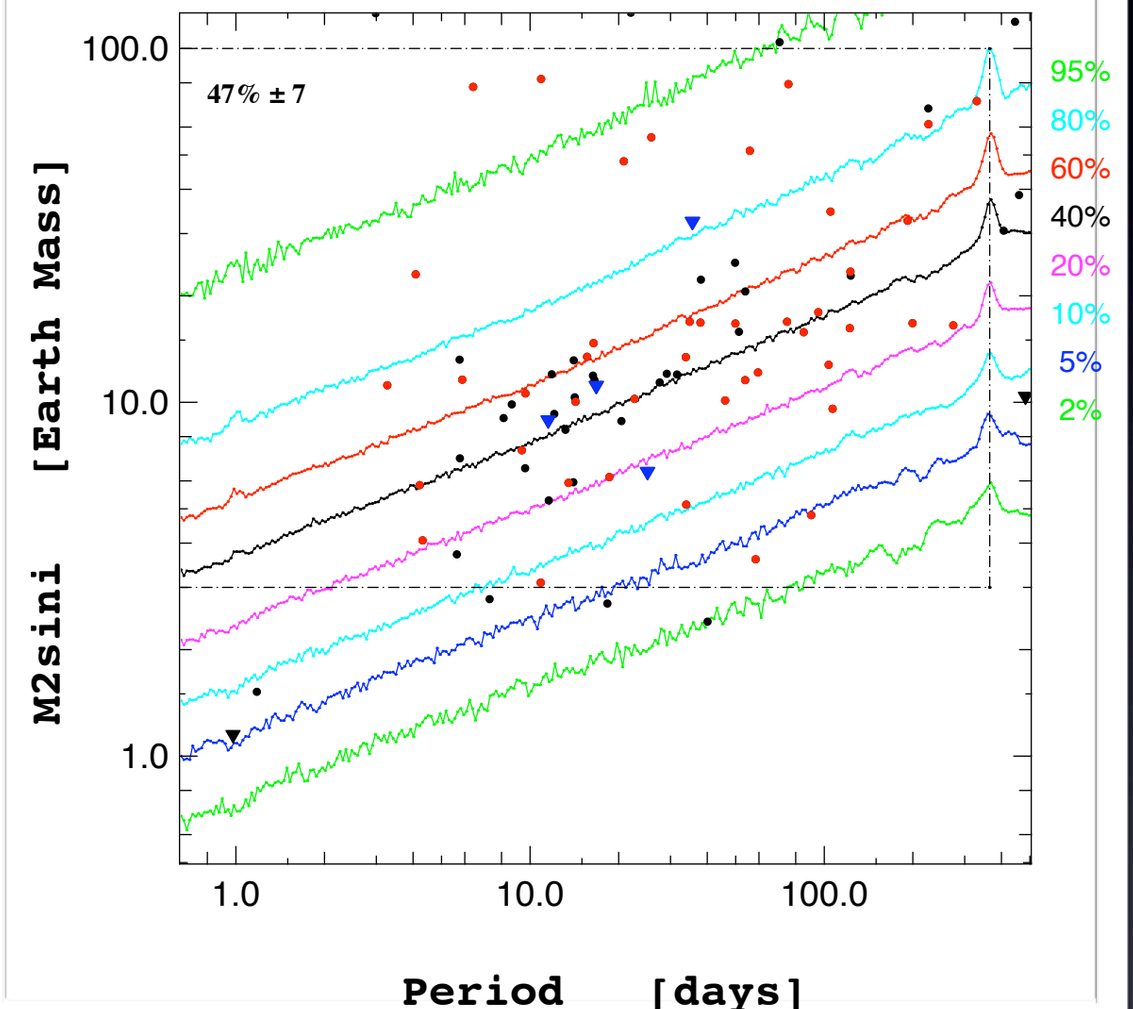
Other sources in litterature



Today : smallest amplitude K= 0.56 m/s

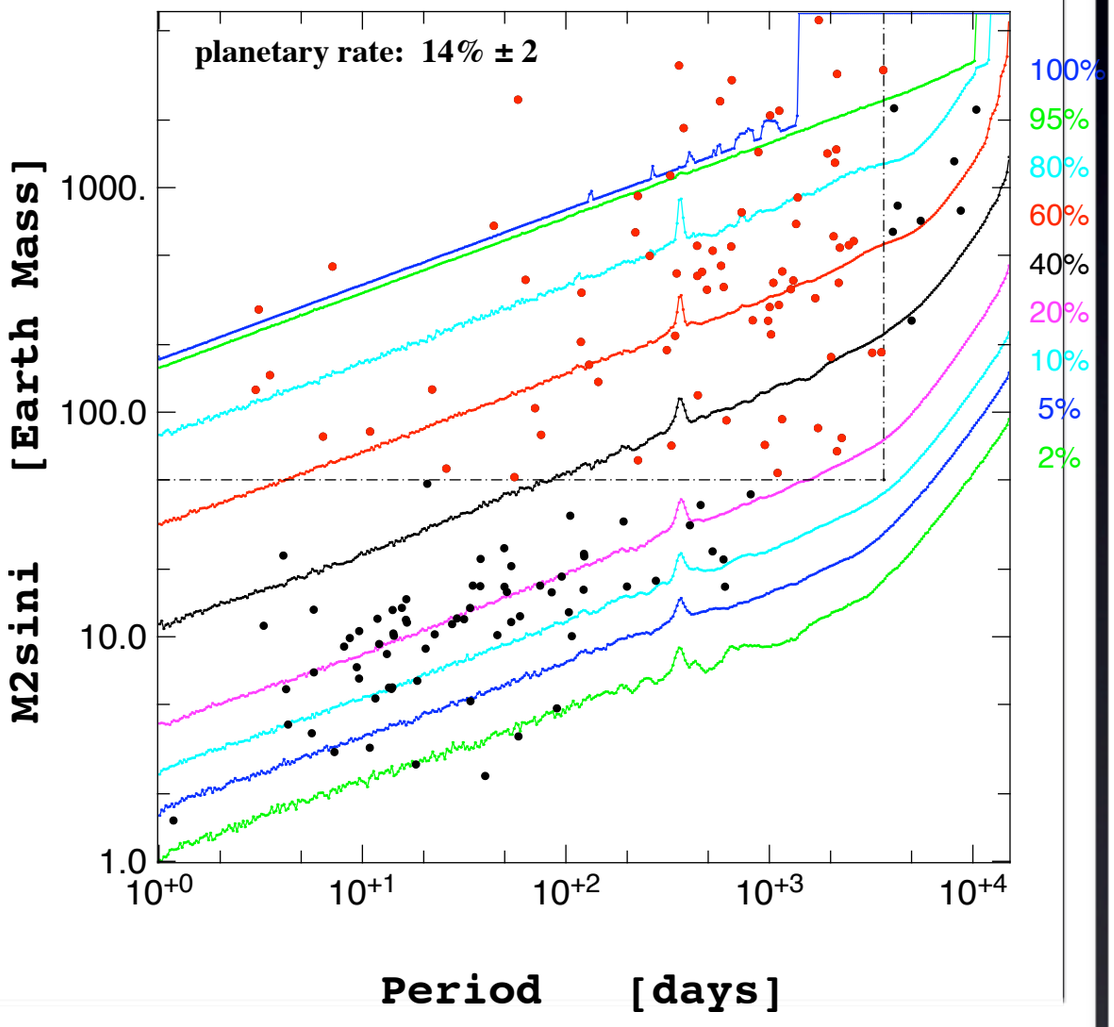
The M2sini - log P plane

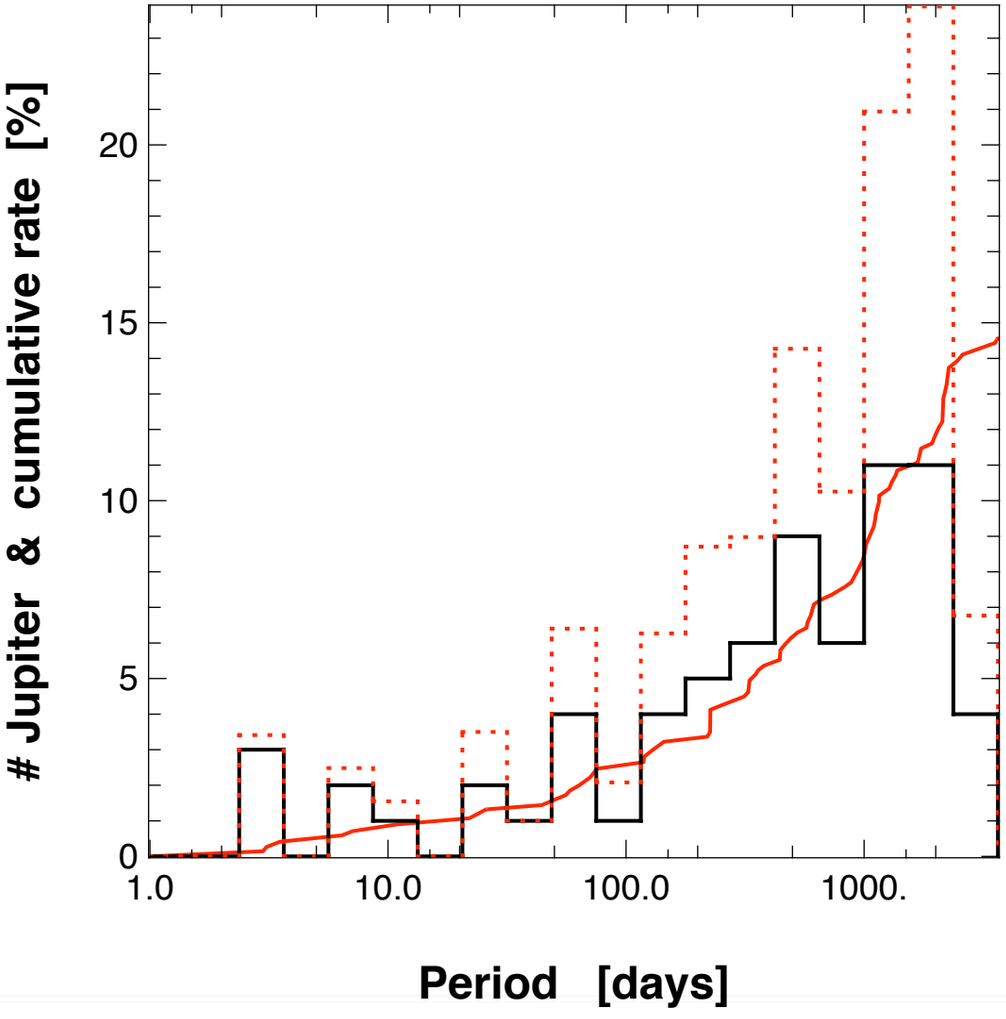




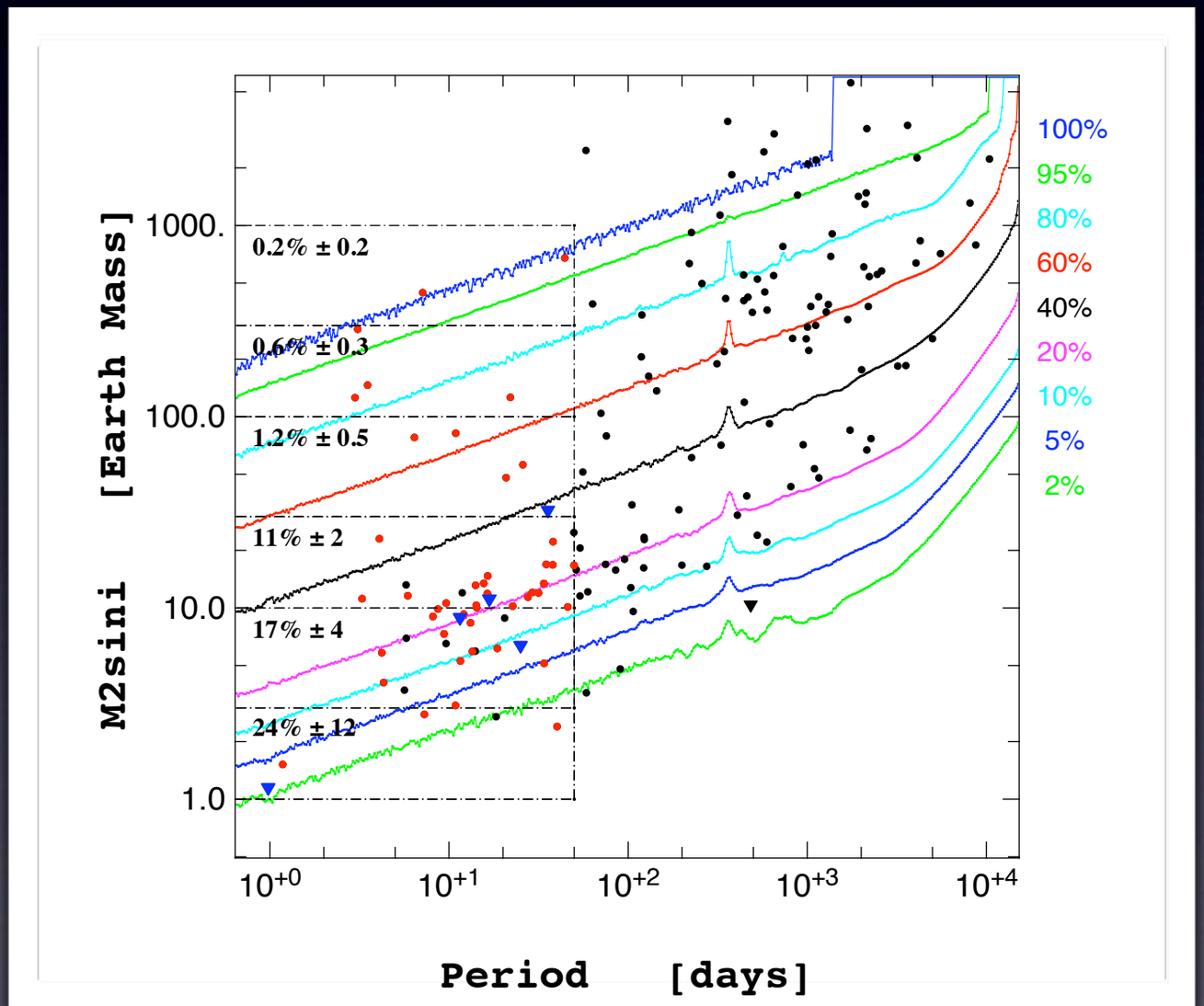
155 planets, 102 systems

Gaseous giant planets (M2sini > 50 Earth-masses)



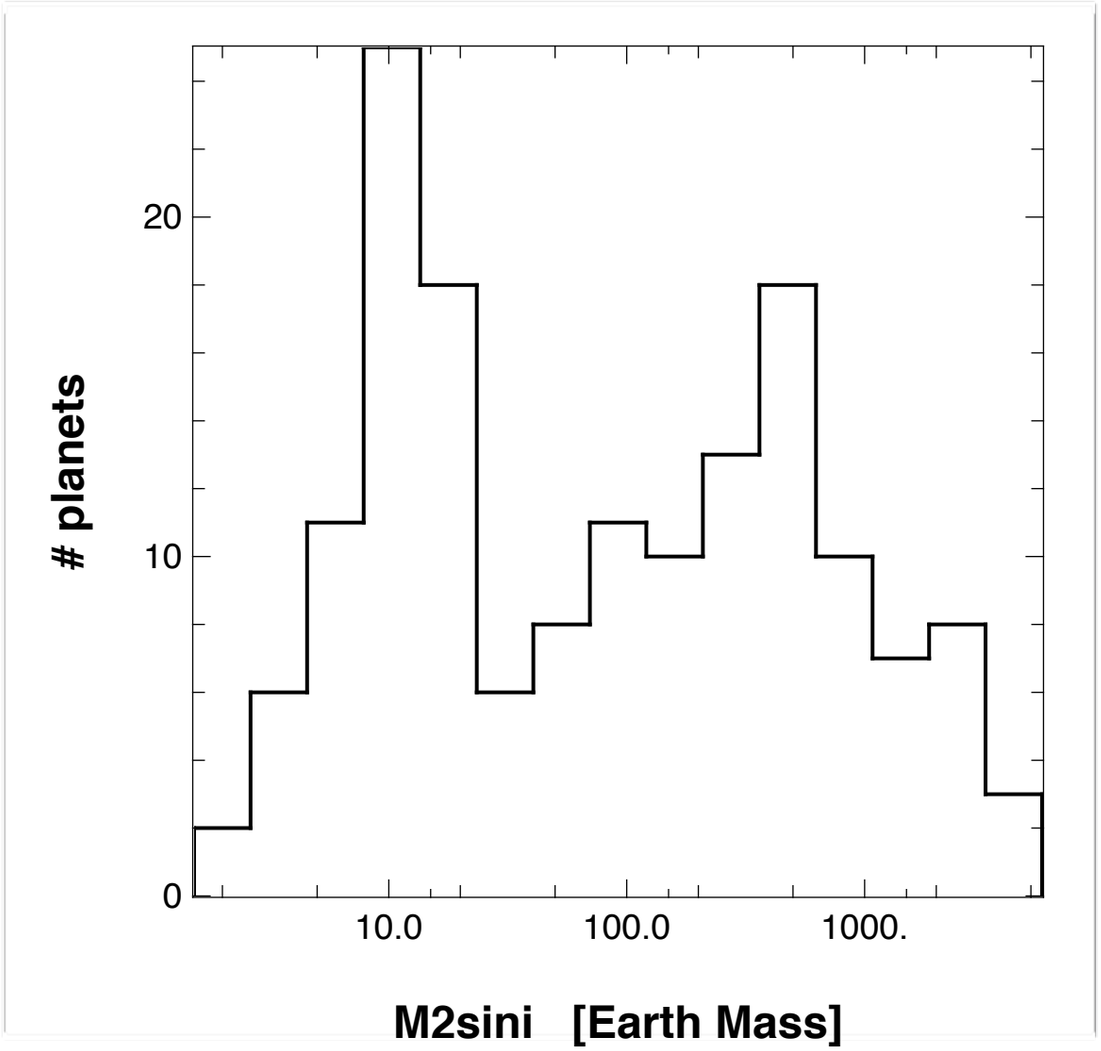


Orbital periods < 50 days

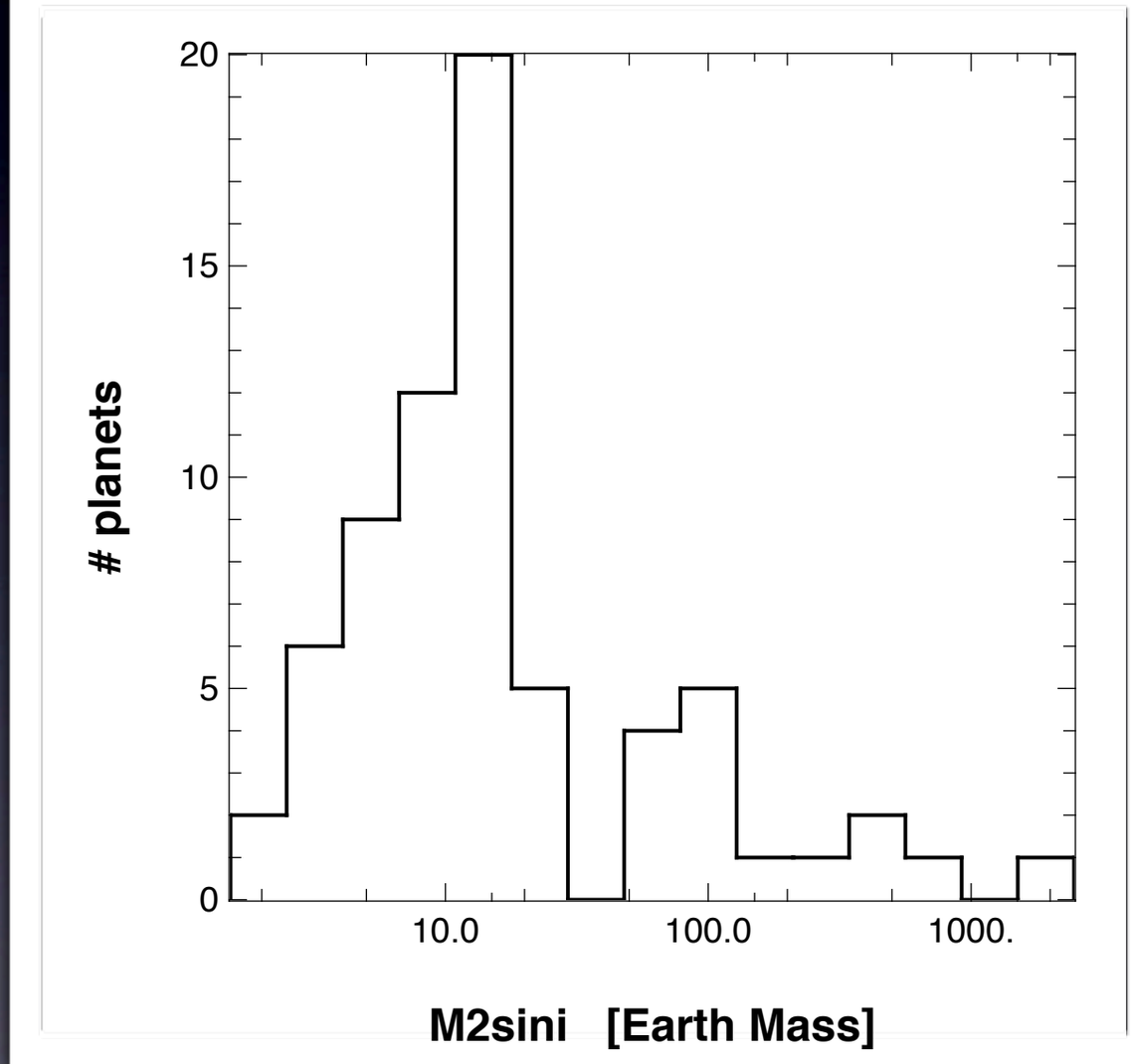


Mass distribution

Detections in the global sample

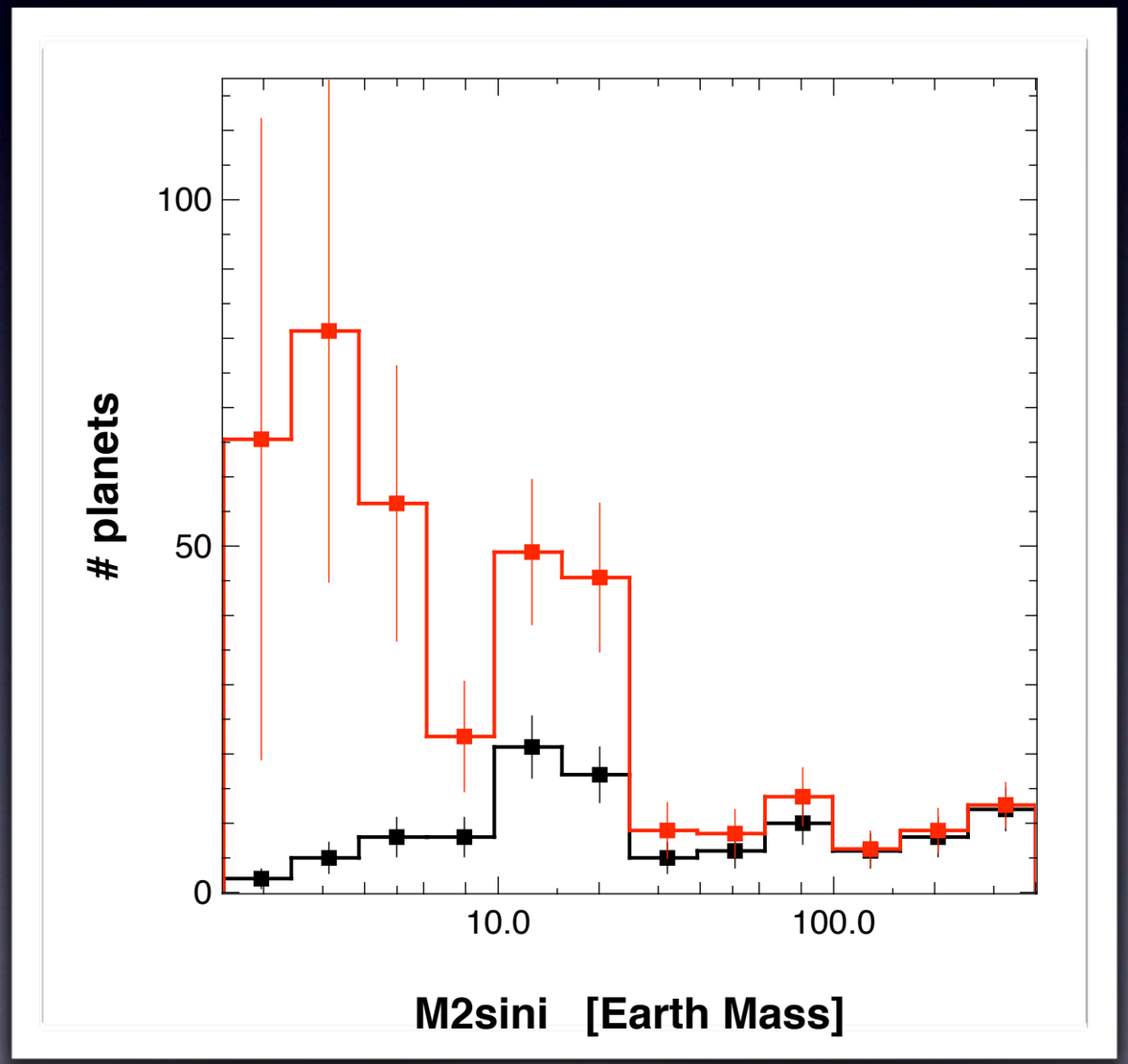


...and for P < 100 days
huge occurence of
planets with m2sin < 30
Earth-masses

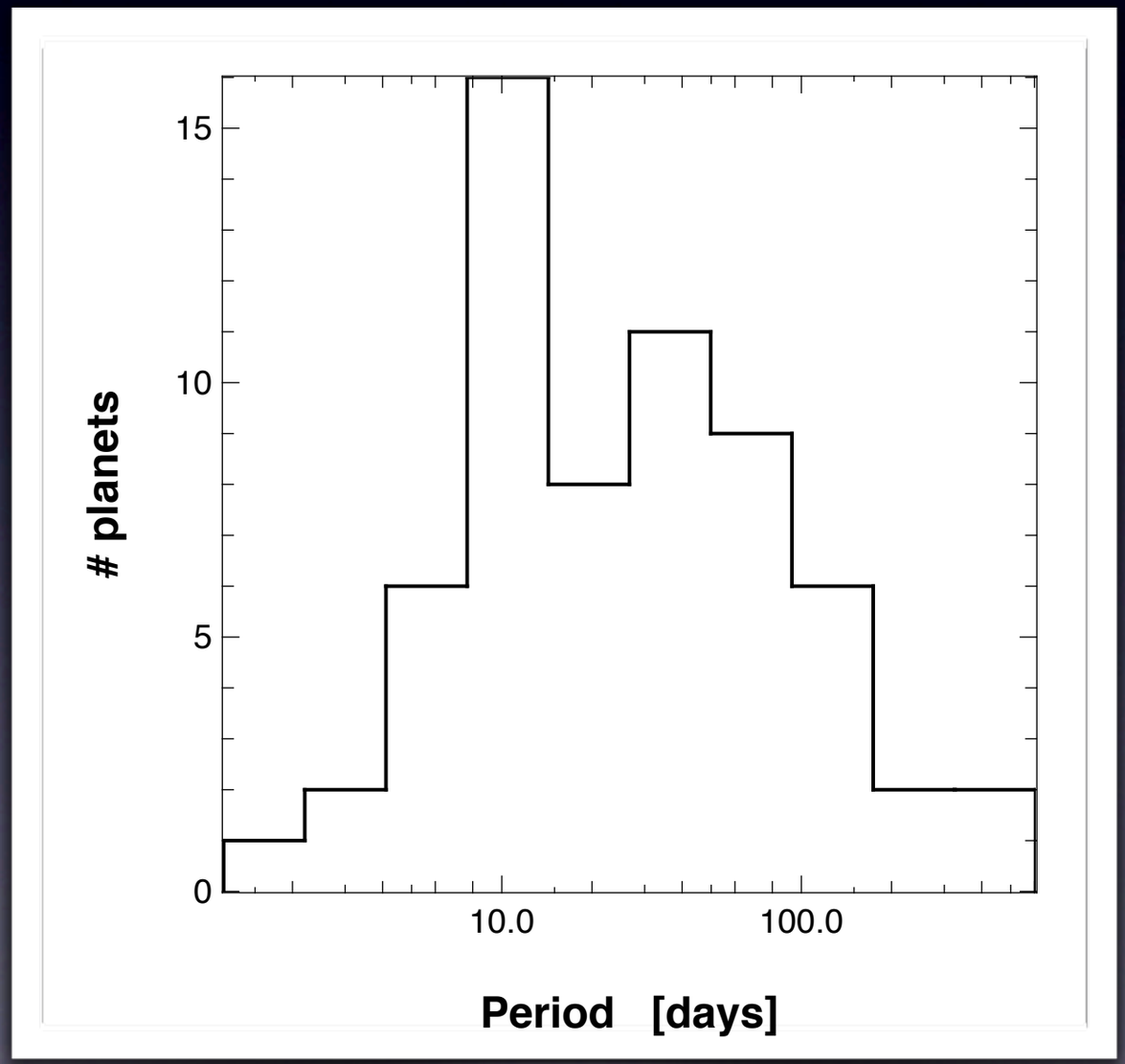


Mass distribution :

.... with detection probability correction



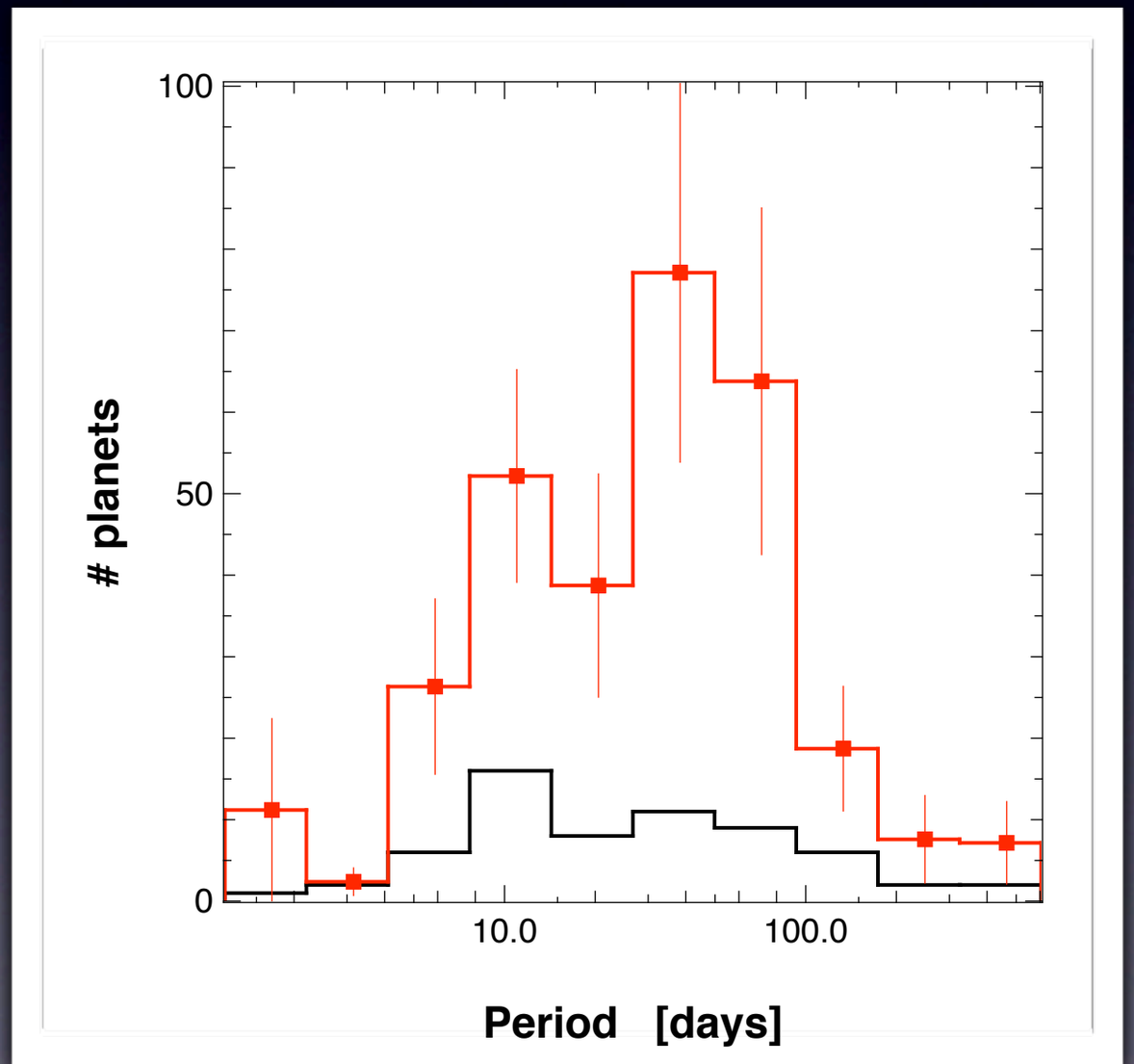
Observed Period distribution for M2sini < 30 Earth-masses



Period distribution

M2sini < 30 Earth-masses

With detection probability correction

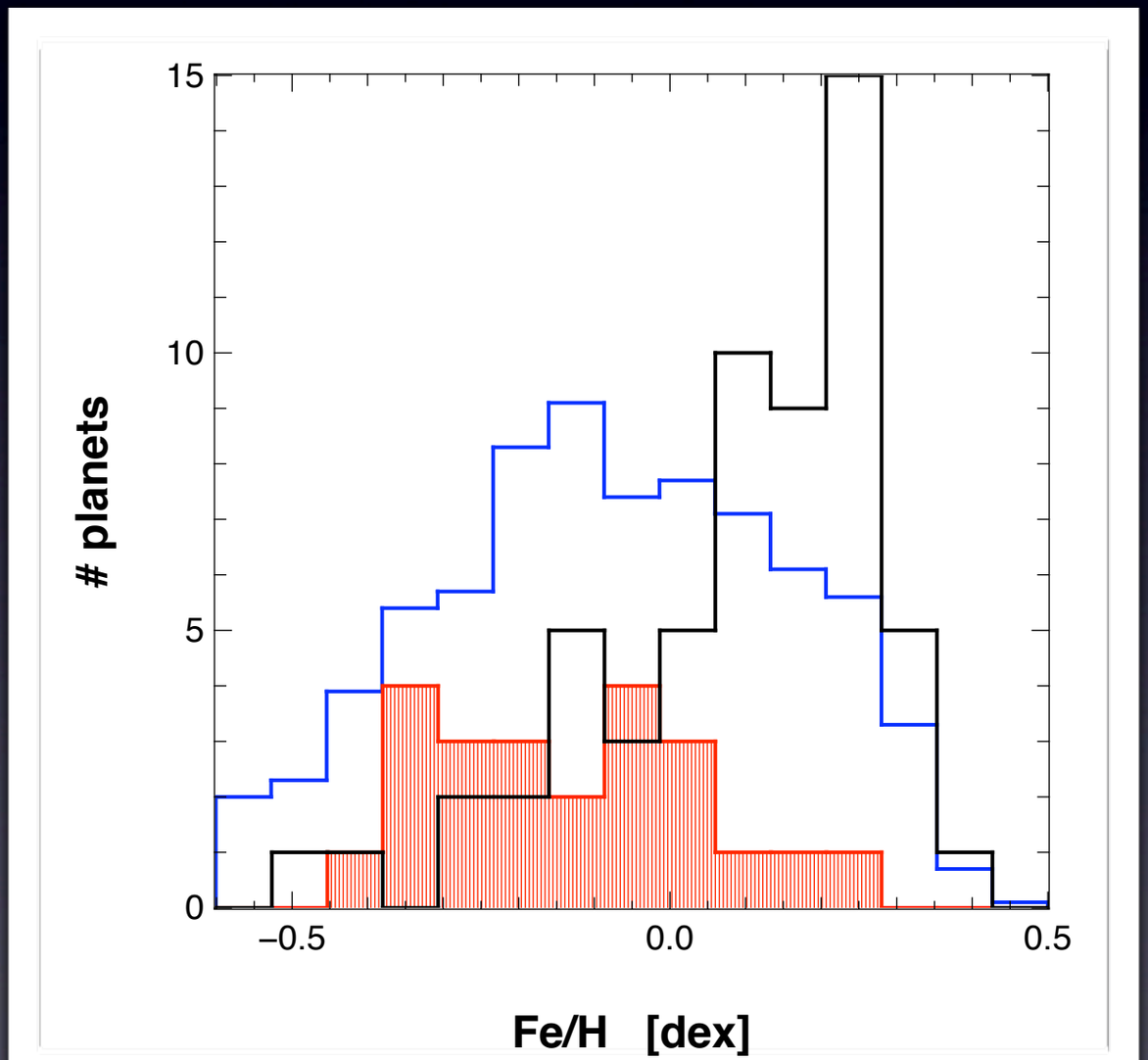


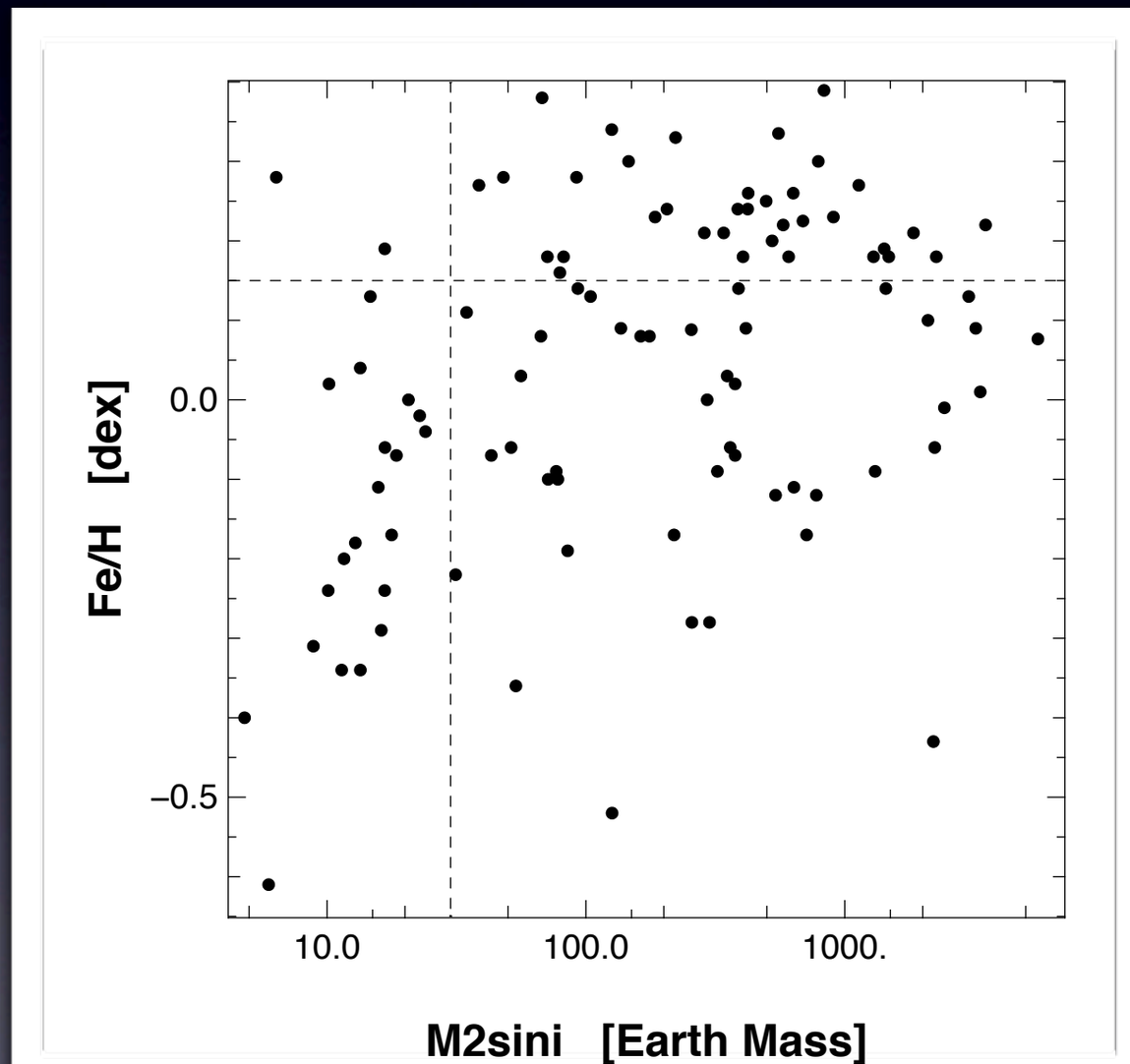
Host star metallicities

Blue : Entire sample

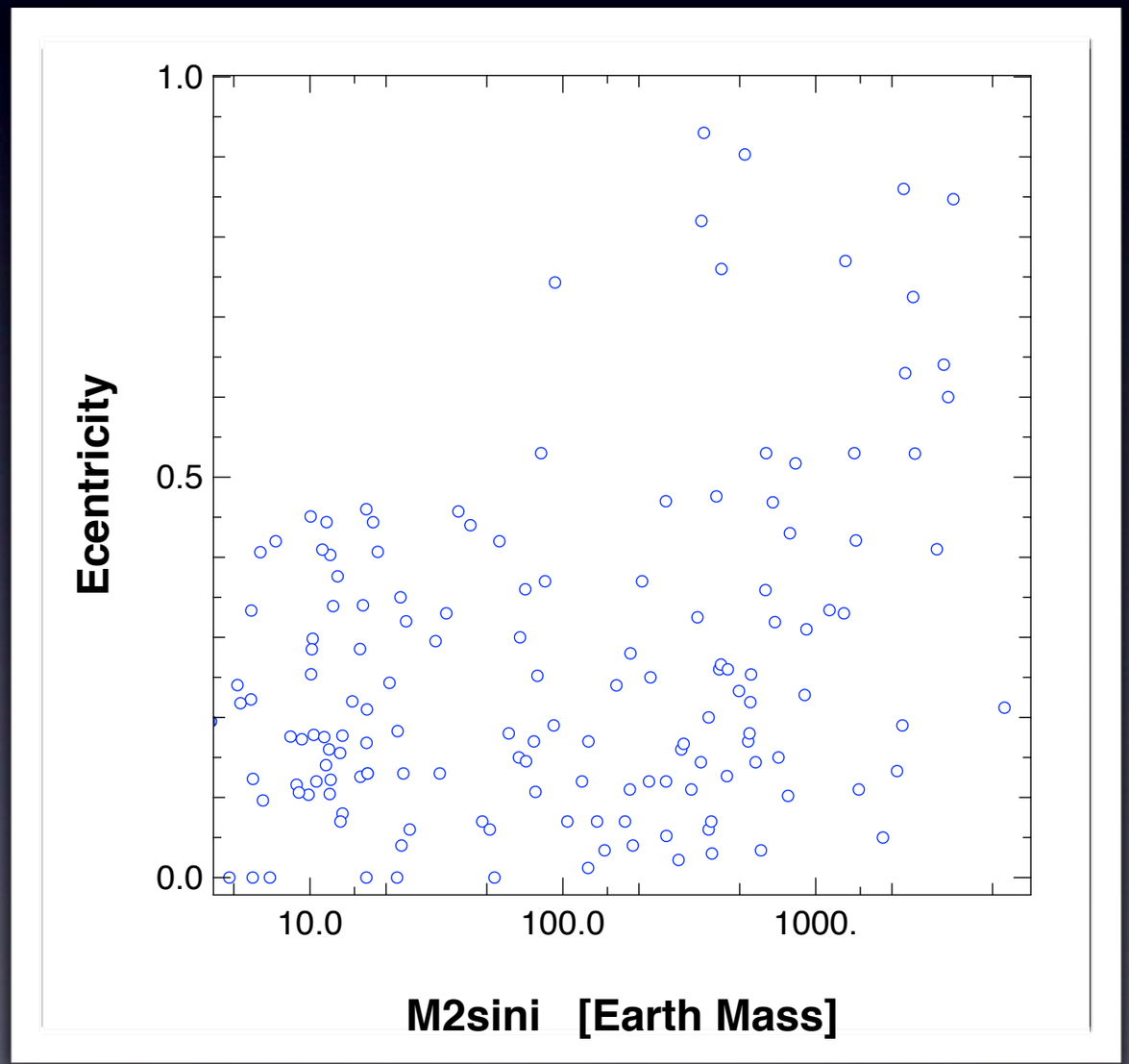
Black : M2sini > 50 Earth-masses

Red : M2sini < 30 Earth-masses

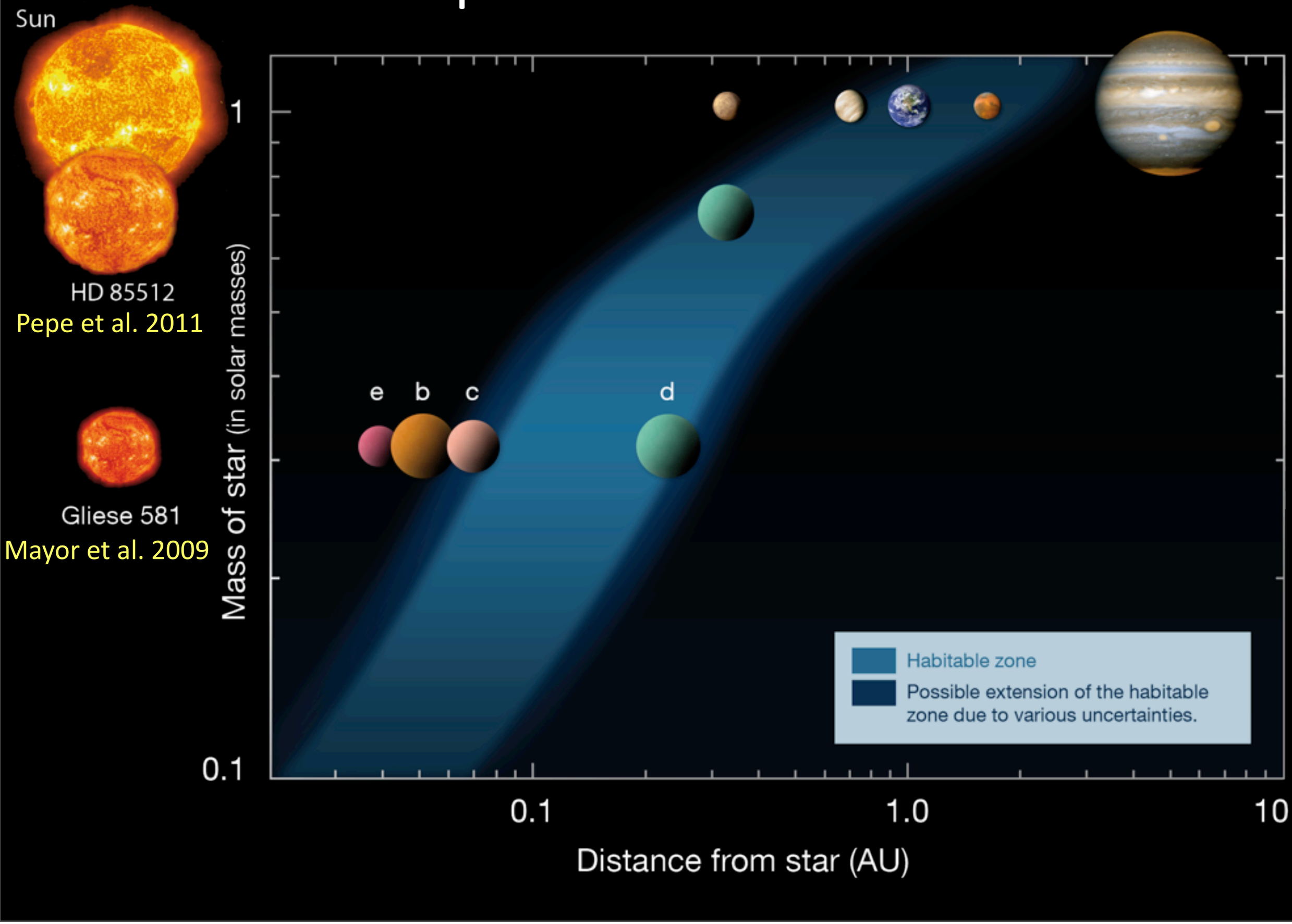




Eccentricities as function of M2sini



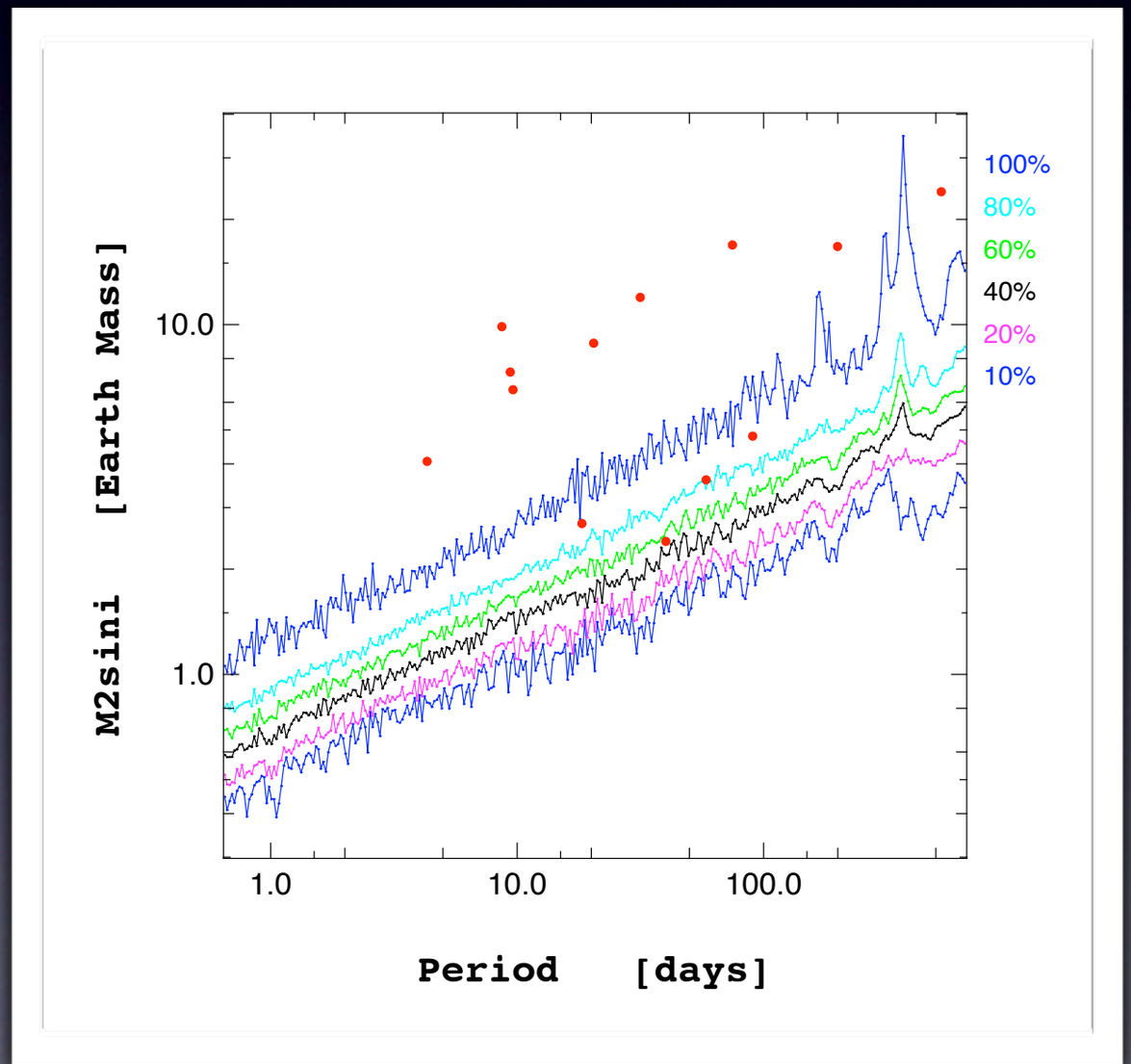
Two Super-Earths in the Habitable zone



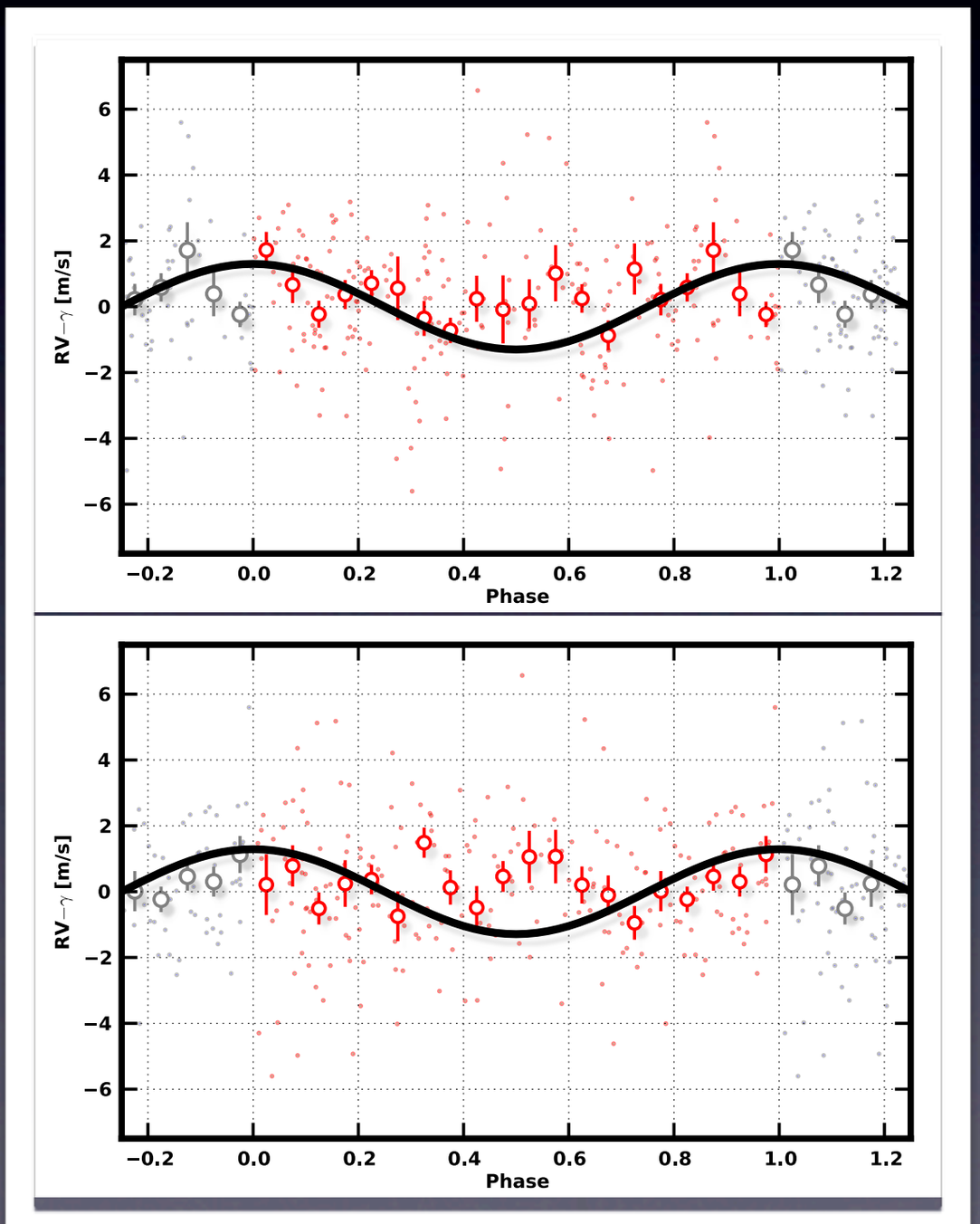
Ten stars with the largest number of HARPS measurements (N > 165)

29 planets hosted by these 10 stars

Super-Earths are detectable up to a period of 1 year



Only 4 planets hosted by GI 581
Forveille et al. 2011 A&A subm.



Based on 240 precise HARPS
The planets announced by
Vogt et al. 2010
GJ 581 f and g do not exist
at least with the claimed
parameters

HARPS RV phased with the
published periods

See also Gregory 2011
and Tuomi 2011

The HARPS Search for Southern Extra-Solar Planets
The M-dwarf sample

Paper on astro-ph

Bonfils et al. (2011, arXiv:1109.xxxx)

Sample:
~100 brightest M dwarfs < 11 pc

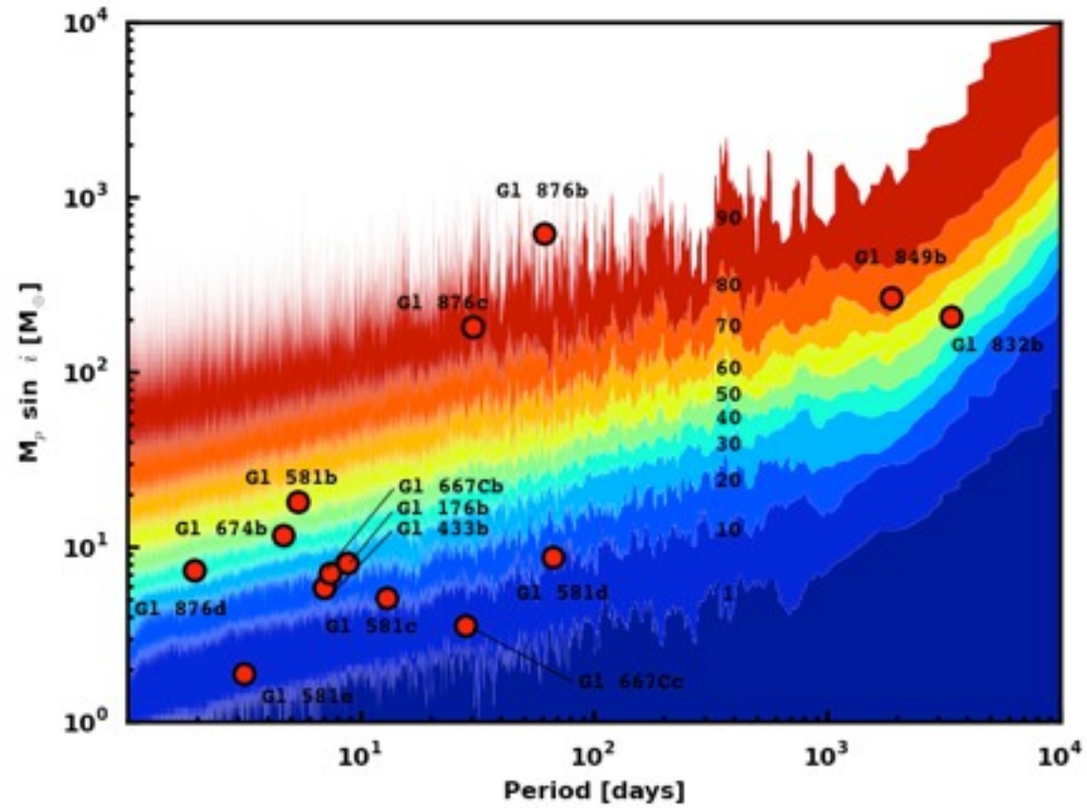
Results:

- 90% of M-dwarfs planets w/ *m* sin *i* < 20 Mearth
- lowest-mass planets (GJ 581e; *m* sin *i* = 1.9 Mearth)
- first prototypes of habitable planets (GJ 581 c&d)
- statistical results :
  - few Jupiter-mass planets

$$f < 1\% \quad \text{for} \quad 1 < P < 10 \text{ day}$$
$$f = 0.02^{+0.03}_{-0.01} \quad \text{for} \quad 10 < P < 100 \text{ day}$$

  - super-Earth are common (>30%)

$$f = 0.36^{+0.25}_{-0.10} \quad \text{for} \quad 1 < P < 10 \text{ day}$$
$$f = 0.52^{+0.50}_{-0.16} \quad \text{for} \quad 10 < P < 100 \text{ day}$$



$$\eta_\oplus = 0.41^{+0.54}_{-0.13}$$

(a direct measure)