The frequency of giant planets around metal-poor stars

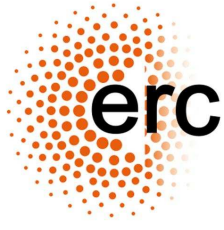
Annelies Mortier

CAUP, Porto

Nuno C. Santos
Dave Latham

Alessandro Sozzetti
Xavier Bonfils

Michel Mayor
Stephane Udry



U.PORTO

FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

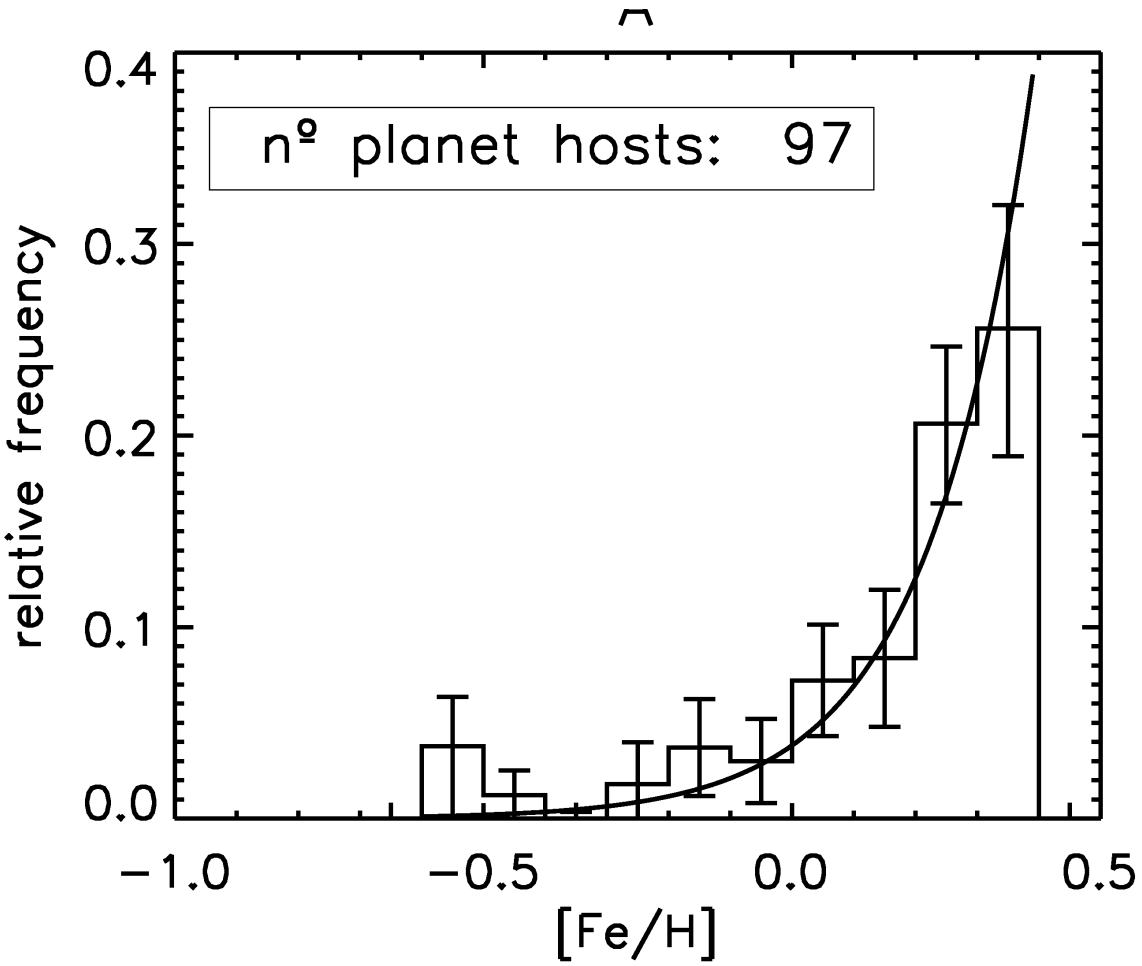
Outline

Introduction

- Over 750 planets discovered
- Several detection methods:

  Direct imaging, **Photometry (transits), Radial Velocity**, Astrometry, Microlensing, Pulsar timing
- Theory of planet formation and evolution still under debate (Pollack et al. 1996, Mayer et al. 2002, Mordasini et al. 2009)
- Stellar mass, metallicity, disk composition, ... influence planet formation processes (Santos et al. 2004, Lovis & Mayor 2007)
- Specific samples to search for planets (e.g. Bonfils et al. 2005, Fischer et al. 2005, Santos et al. 2007, Sozzetti et al. 2009)

Giant planet frequency

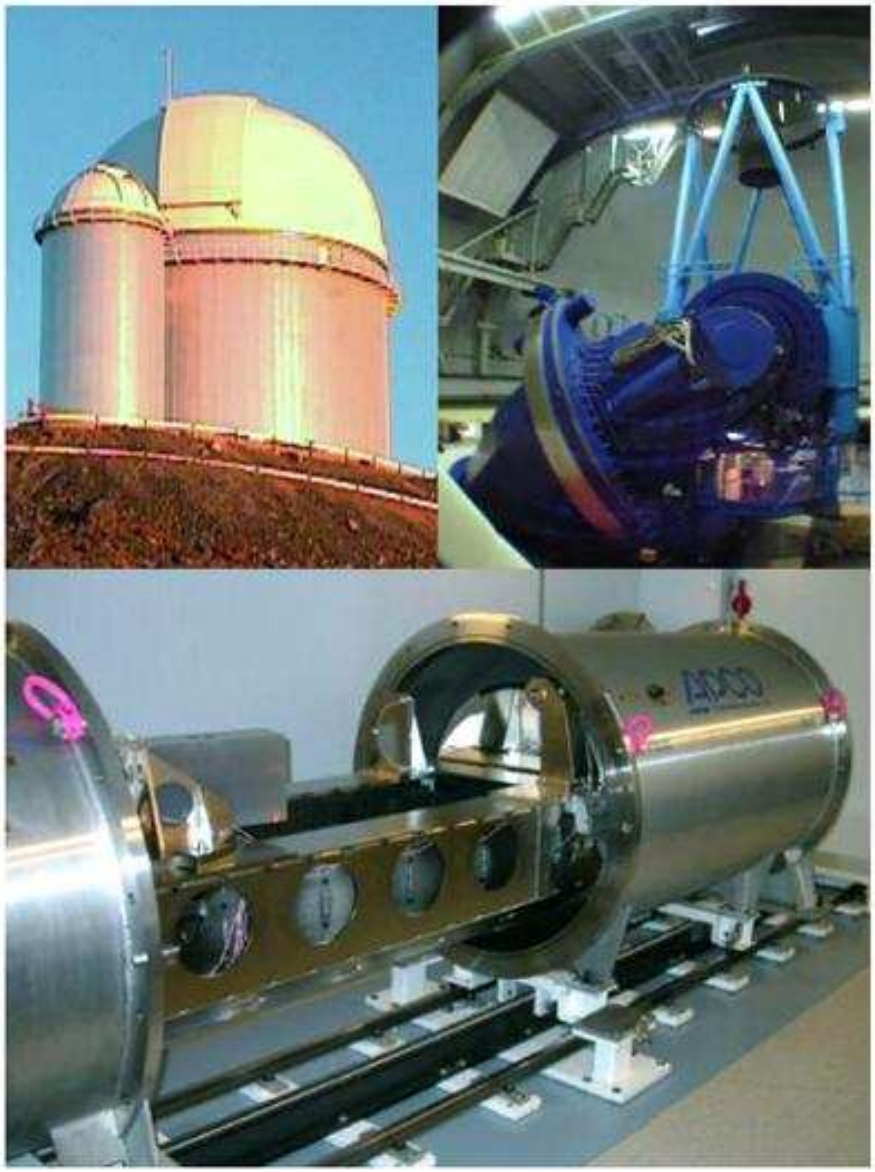


(Sousa et al. 2011)

The data - Keck/HIRES sample (Sozzetti et al. 2009)

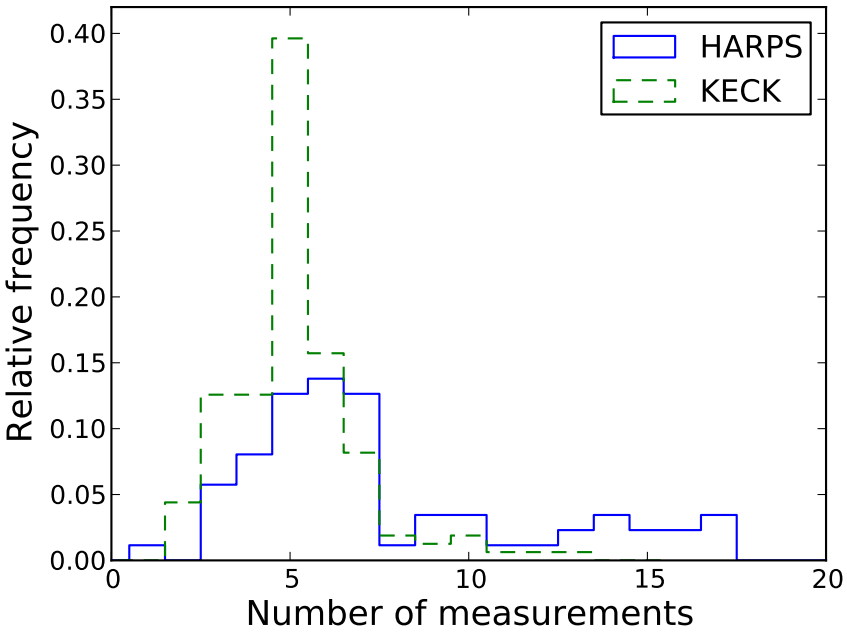
- 160 metal-poor solar-type stars
- Instrument: HIRES @ Keck 1 Telescope
- Observed from early 2003 till early 2006
- Most stars have 4 to 10 measurements
- RV rms of $\sim 9\ \mathrm{m\,s^{-1}}$

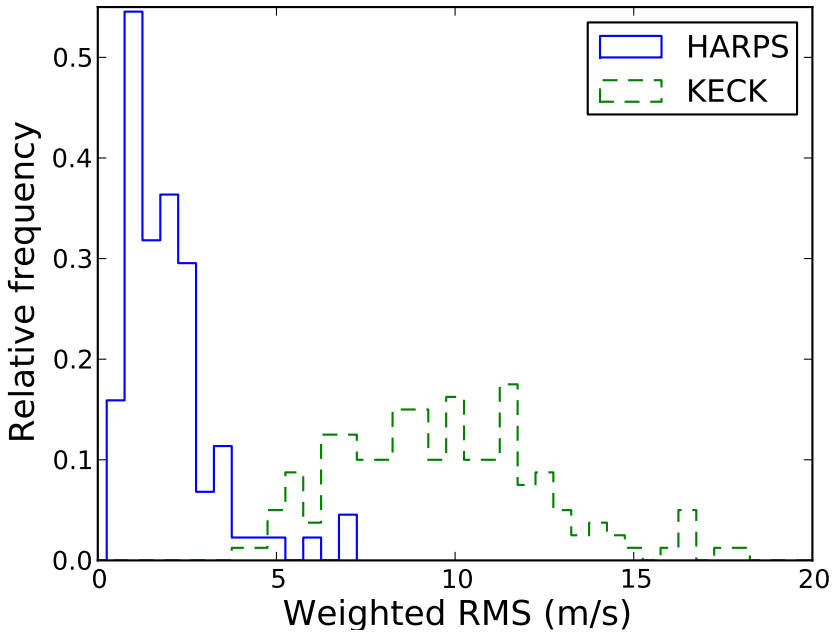
The data - HARPS sample (Santos et al. 2011)



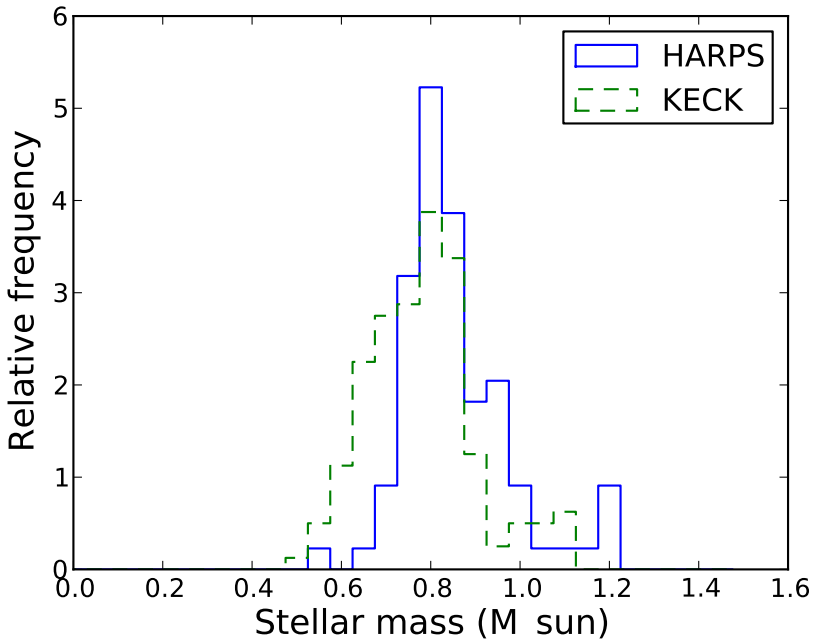
- 104 metal-poor or mild metal-poor solar-type stars
- Instrument: HARPS @ La Silla
- Observed from October 2003 till July 2010
- Most stars have 5 or more measurements
- RV rms of $\sim 1 - 2.5\,\mathrm{m\,s^{-1}}$
- 3 previously announced planets detected
- 1 planet candidate

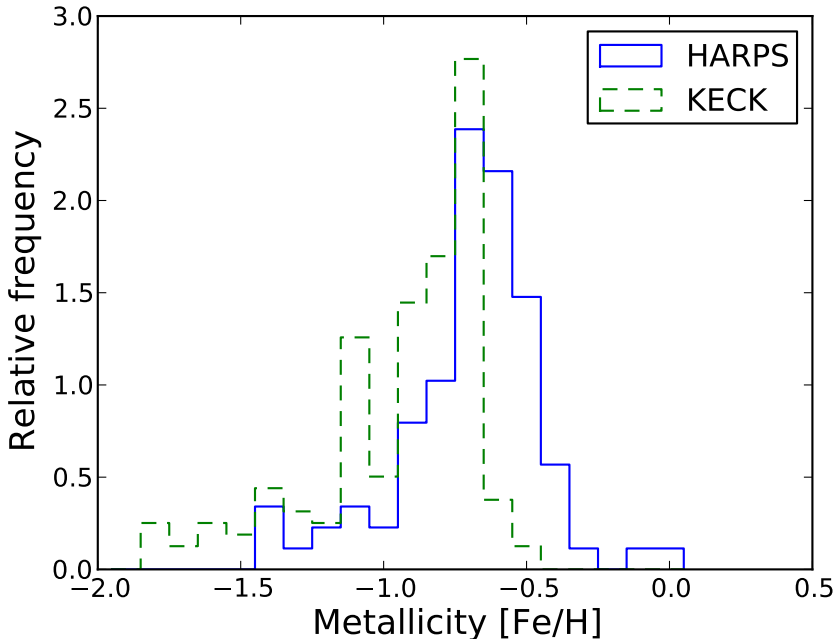
The data


HARPS
KECK
Relative frequency
Number of measurements
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0
5
10
15
20


HARPS
KECK
Relative frequency
Weighted RMS (m/s)
0.0
0.1
0.2
0.3
0.4
0.5
0
5
10
15
20

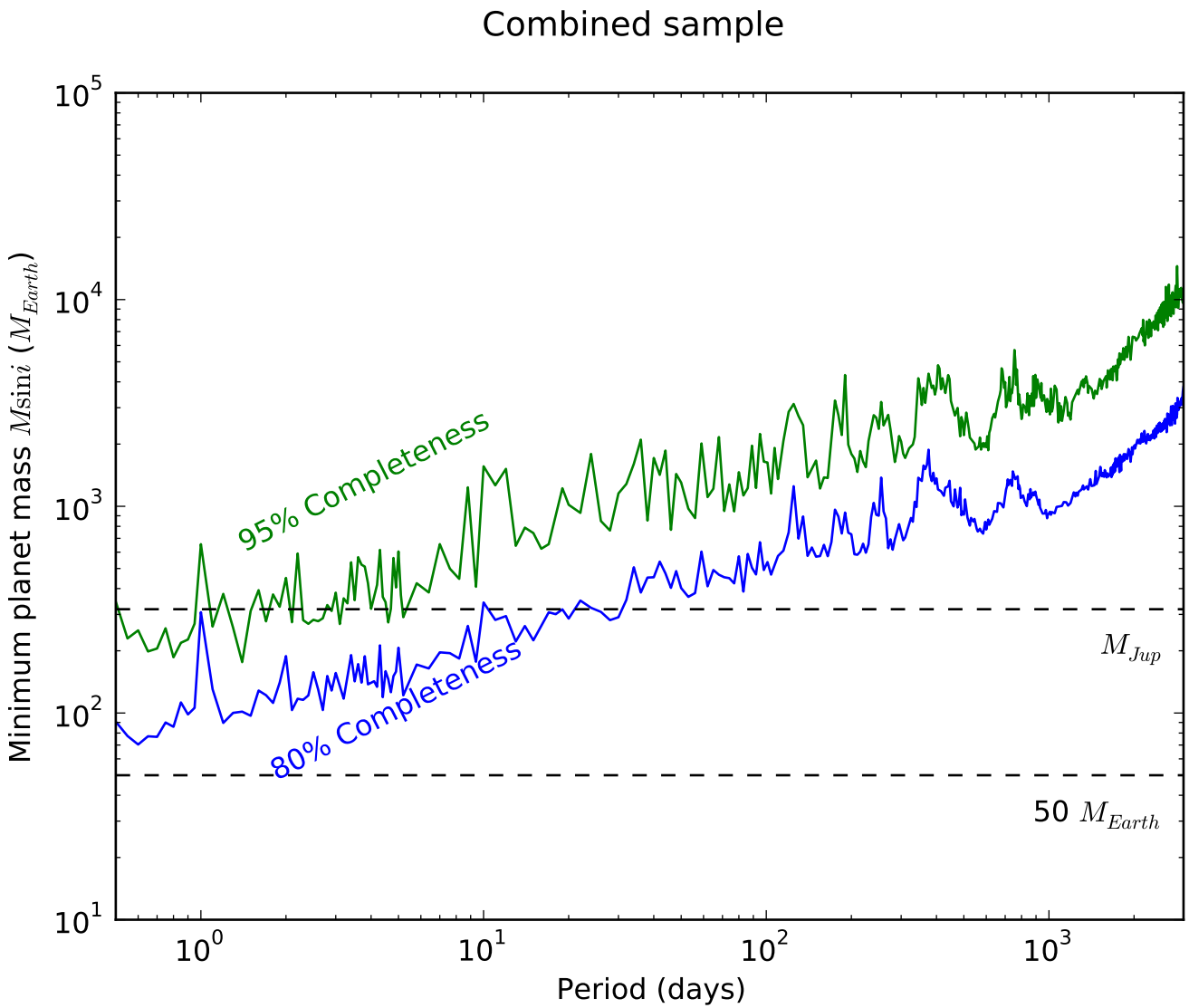
The data





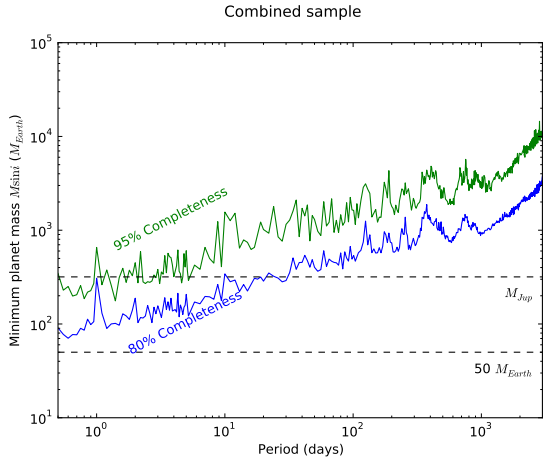
(Mortier et al. 2012)

Detection limits



(Mortier et al. 2012)

Planet frequency



Results

- Hot Jupiters:

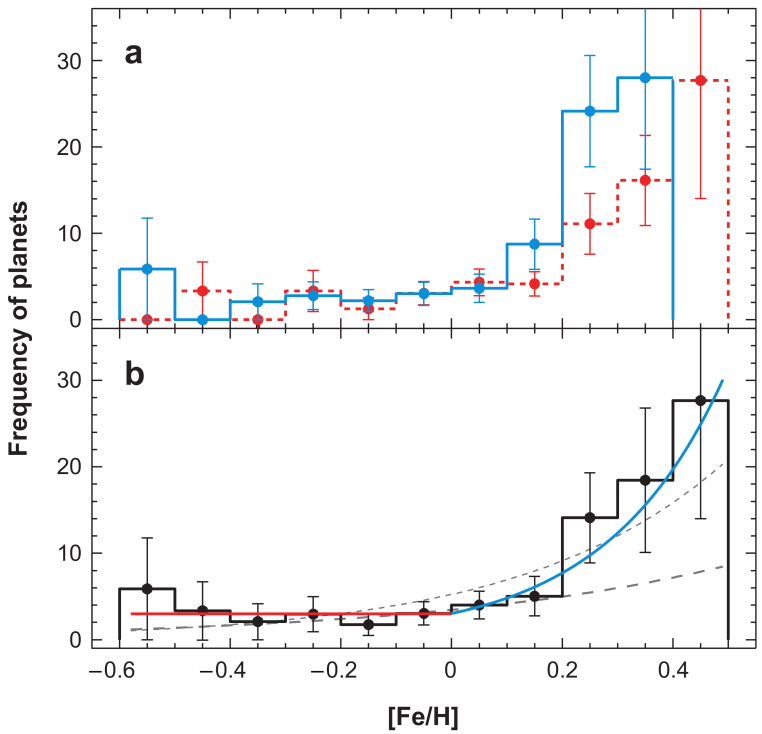
$$f_p \leq 1.0\%$$

- Giant planets:

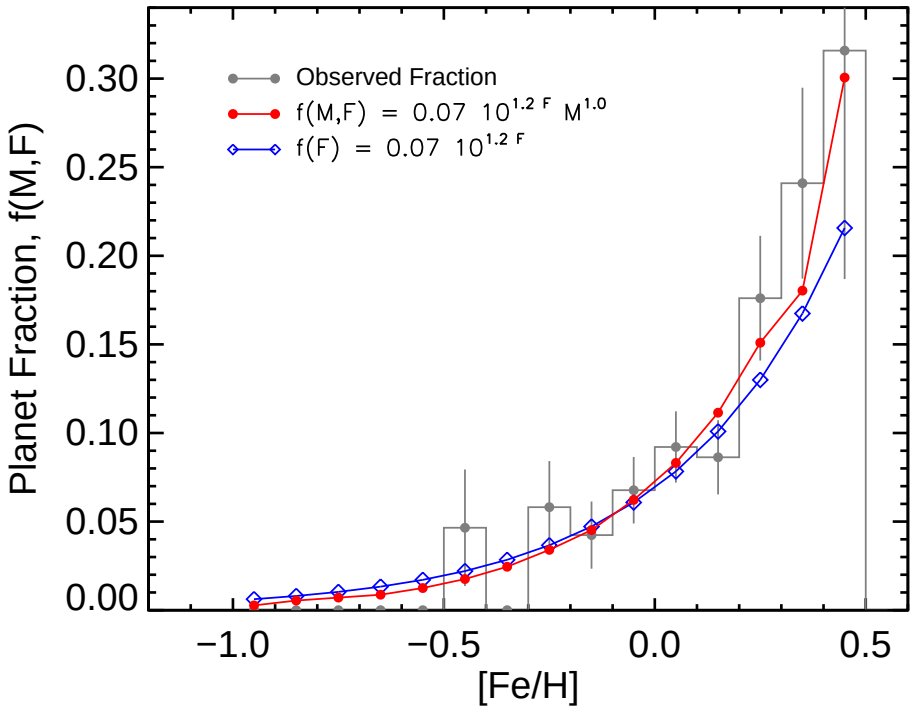
$$f_p = 4.48^{+4.04}_{-1.38}\% \quad \text{if [Fe/H]} > -0.7$$

$$f_p \leq 2.36\% \quad \text{if [Fe/H]} \leq -0.7$$

Functional form lower tail

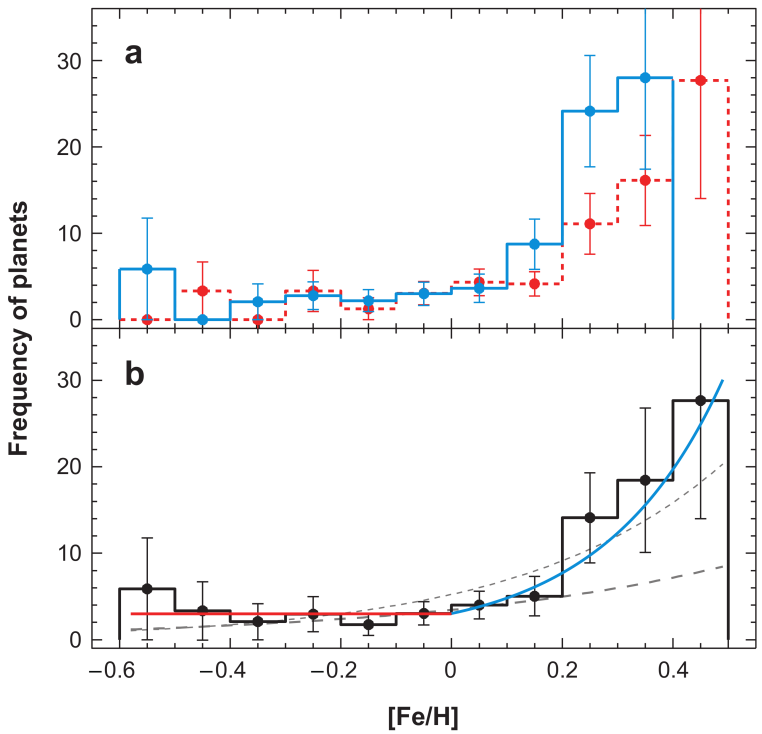


(Udry & Santos 2007)

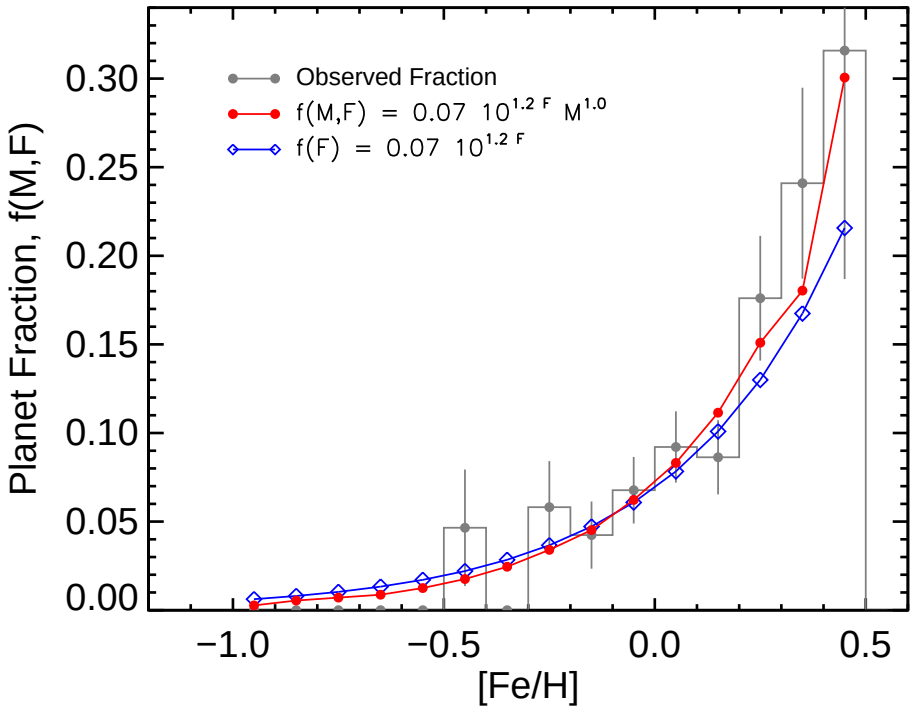


(Johnson et al. 2010)

Functional form lower tail



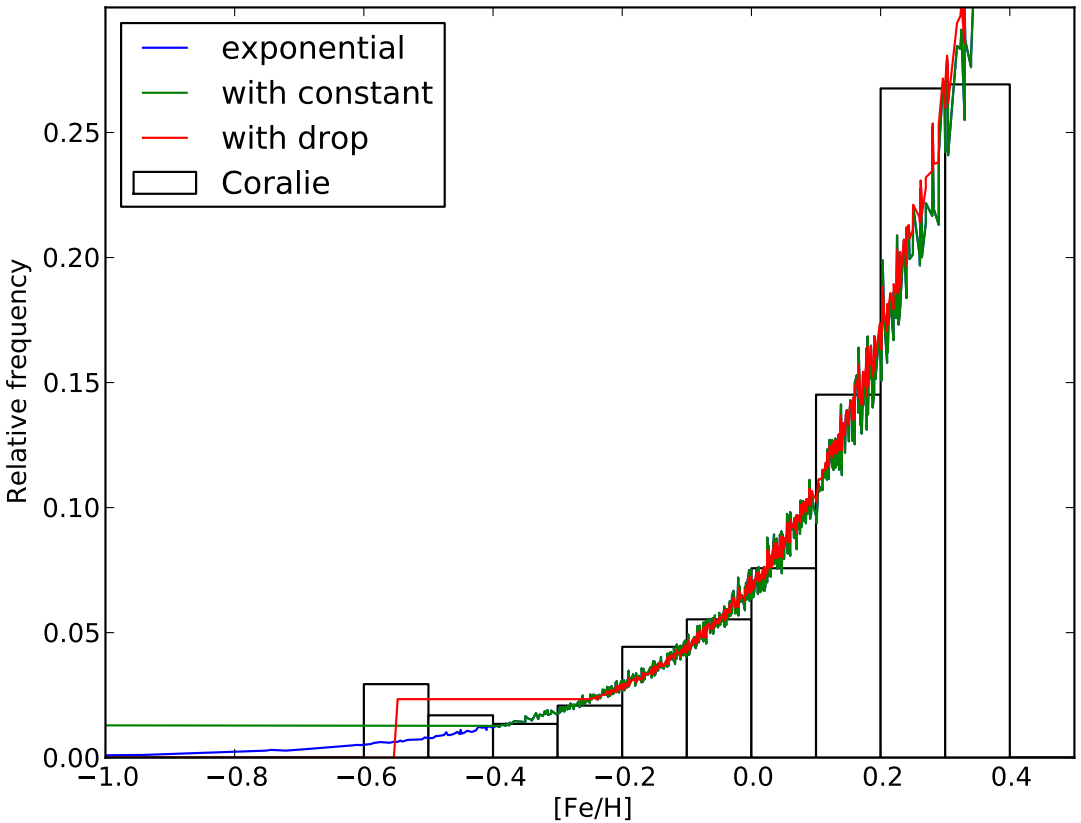
(Udry & Santos 2007)



(Johnson et al. 2010)

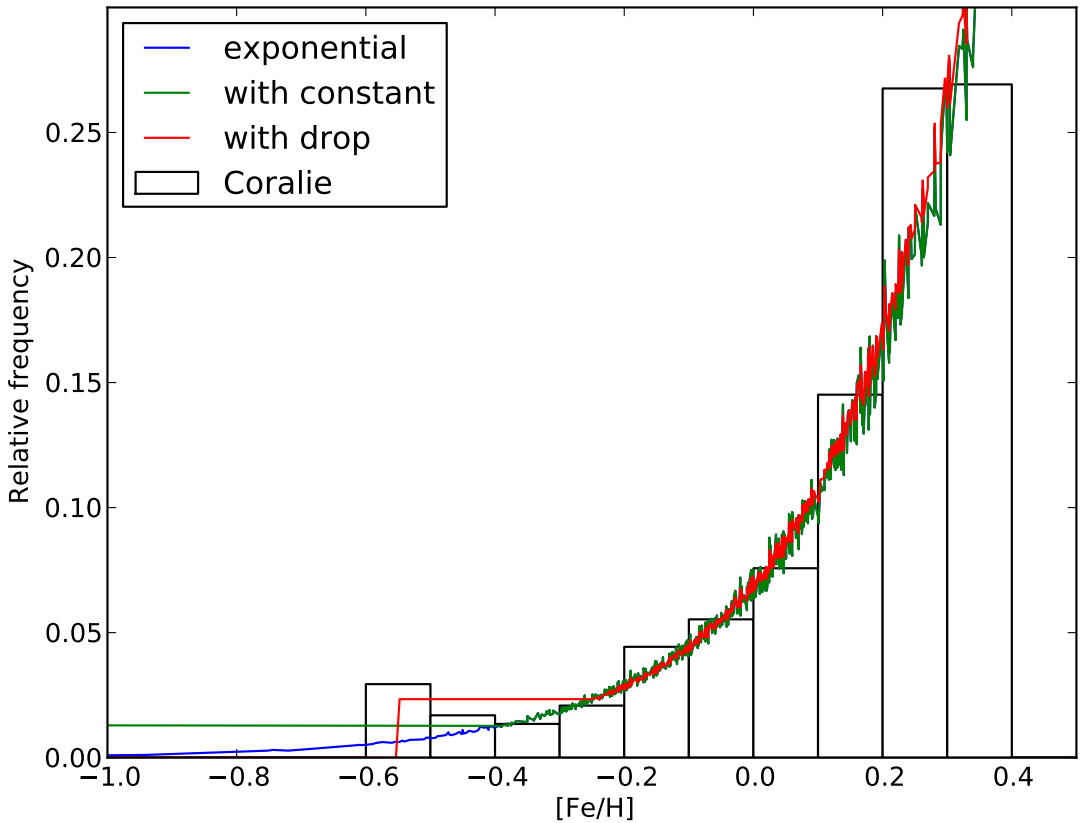
Flat or exponential tail?

Bayesian analysis



(Mortier et al., in prep.)

Bayesian analysis

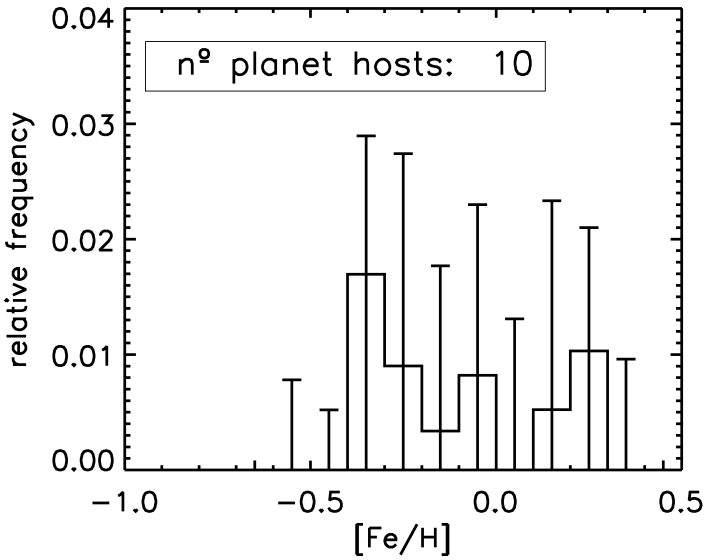


(Mortier et al., in prep.)

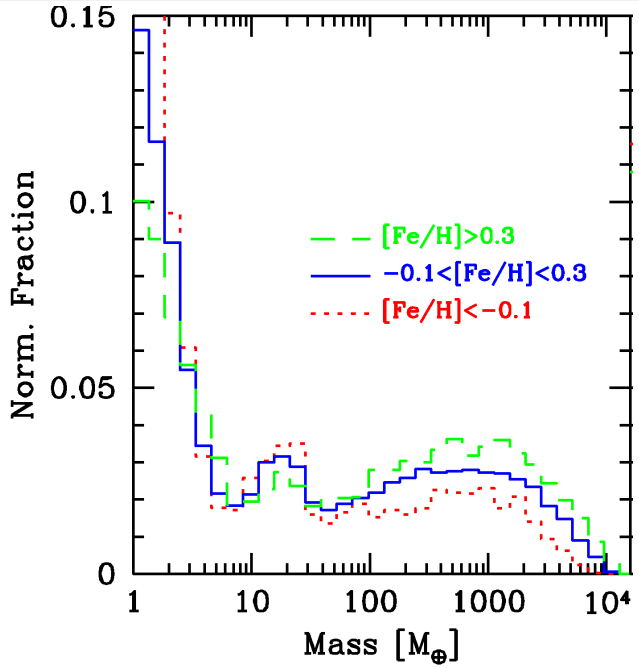
No statistical difference between a flat or exponential tail!

Neptune frequency

For low-mass planets, this metallicity correlation seems not to exist



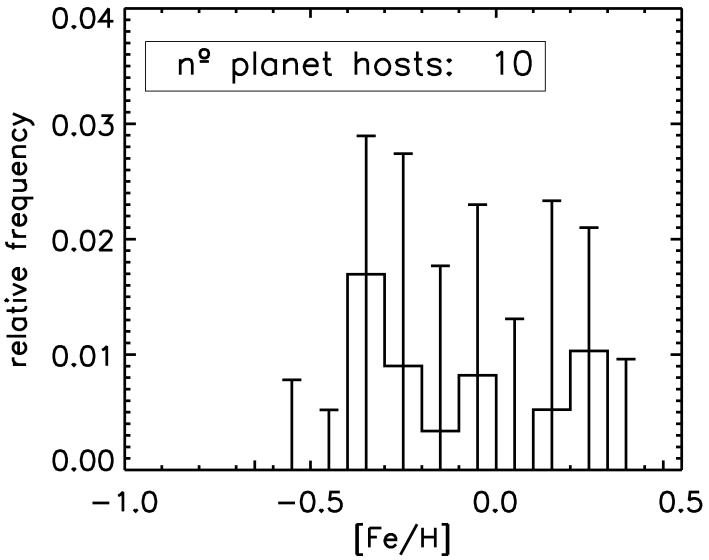
(Sousa et al. 2011)



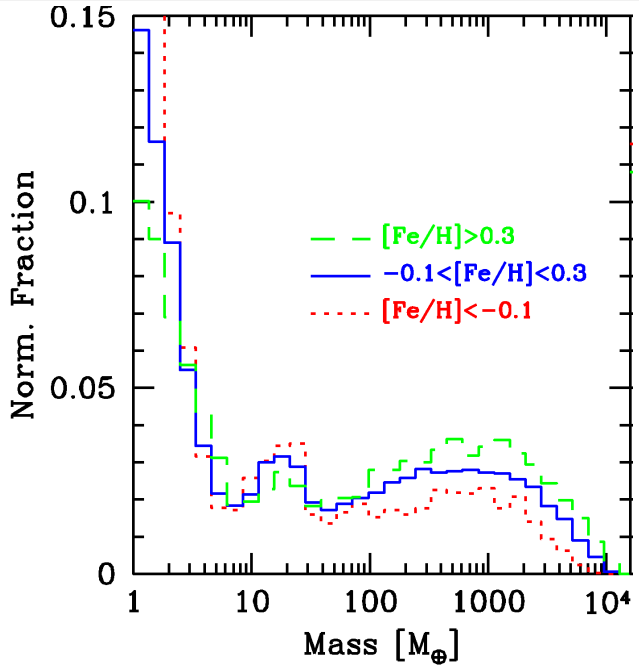
(Mordasini et al. 2012)

Neptune frequency

For low-mass planets, this metallicity correlation seems not to exist



(Sousa et al. 2011)



(Mordasini et al. 2012)

Large program with HARPS
80 nights over 3 years

Conclusions

- Very metal-poor sample observed with HARPS and/or HIRES
  - Hot Jupiters: $f_p \leq 1.0\%$
  - Giant planets:

$$f_p = 4.48^{+4.04}_{-1.38}\% \quad \text{if [Fe/H]} > -0.7$$

$$f_p \leq 2.36\% \quad \text{if [Fe/H]} \leq -0.7$$

- Lower-metallicity tail of giant planet frequency is still uncertain
- Large follow-up program to determine the Neptune frequency around metal-poor stars

Conclusions

- Very metal-poor sample observed with HARPS and/or HIRES
  - Hot Jupiters: $f_p \leq 1.0\%$
  - Giant planets:

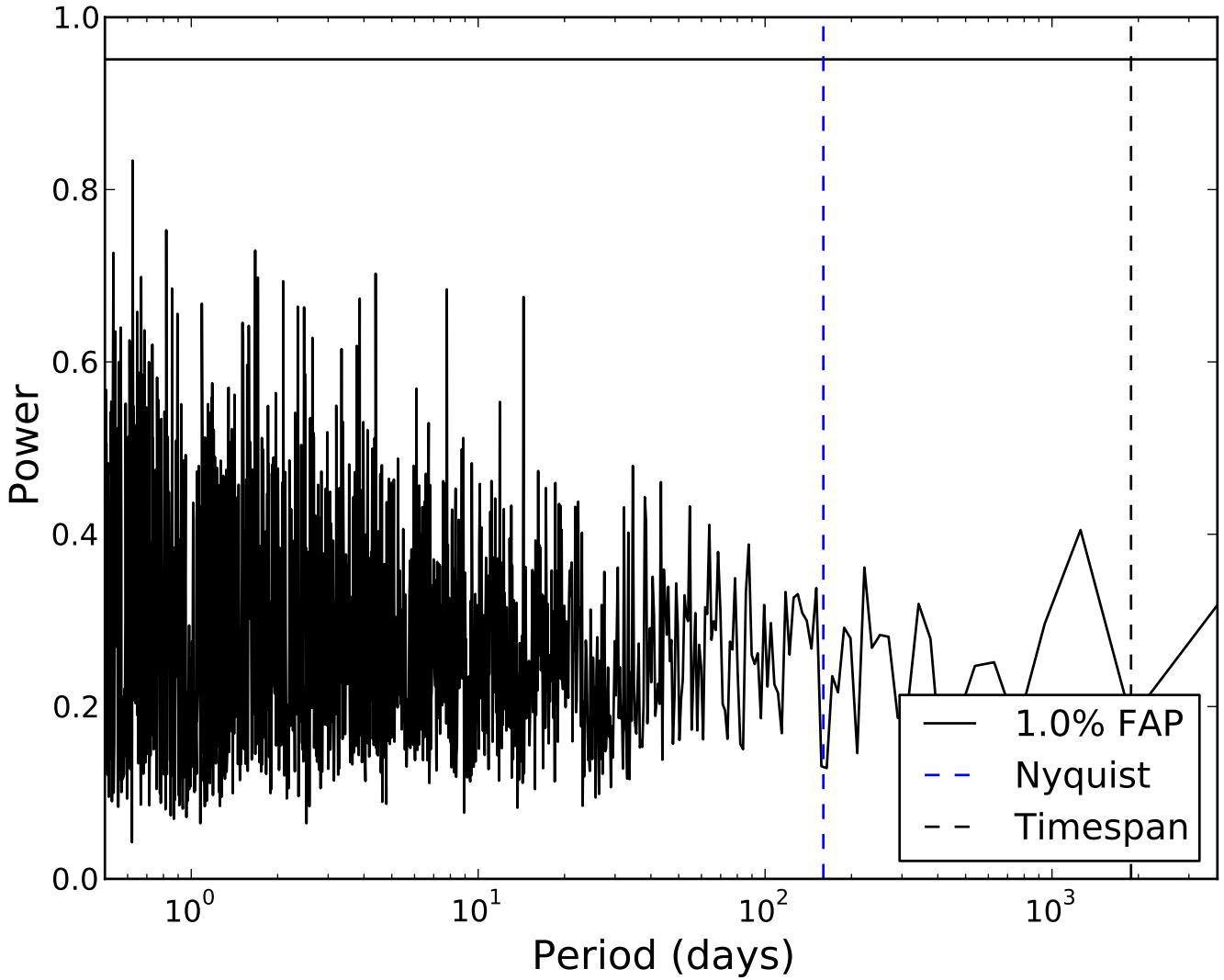
$$f_p = 4.48^{+4.04}_{-1.38}\% \quad \text{if [Fe/H]} > -0.7$$

$$f_p \leq 2.36\% \quad \text{if [Fe/H]} \leq -0.7$$

- Lower-metallicity tail of giant planet frequency is still uncertain
- Large follow-up program to determine the Neptune frequency around metal-poor stars

Thank you

Conclusions



Conclusions