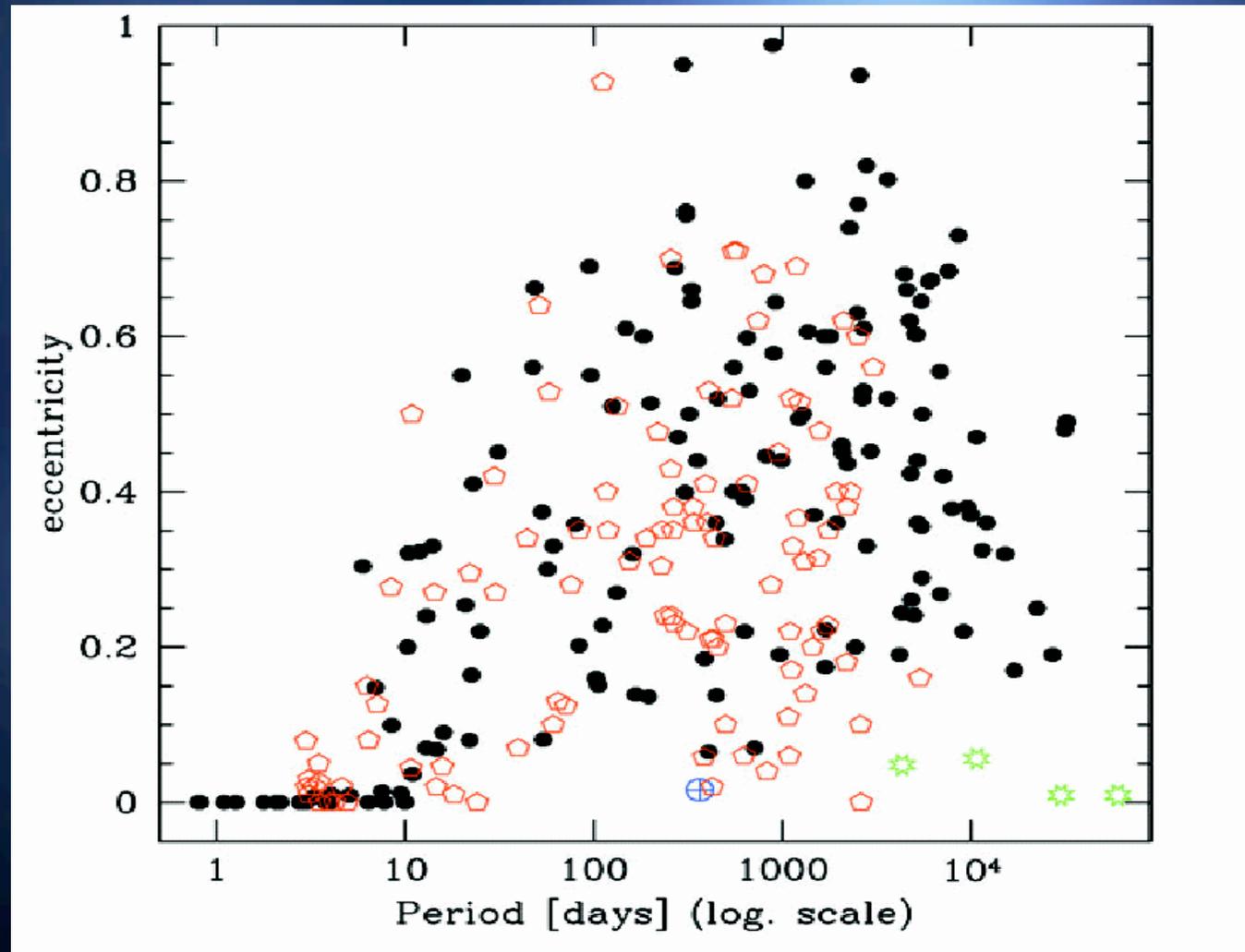


# ***Planets of young stars***

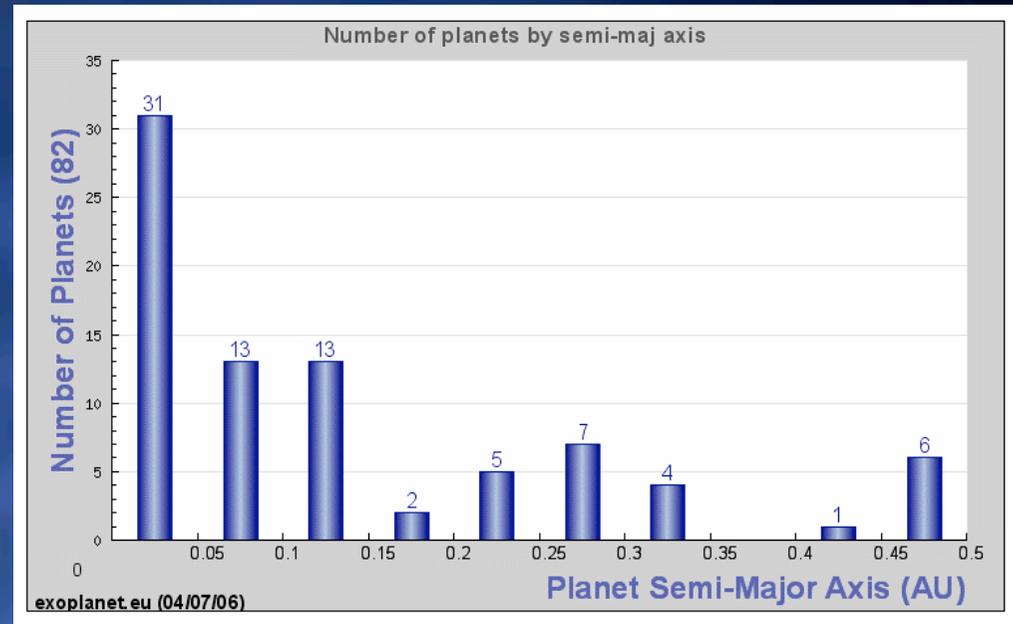
*(part of TOPS)*

Eike Guenther  
Massimiliano Esposito

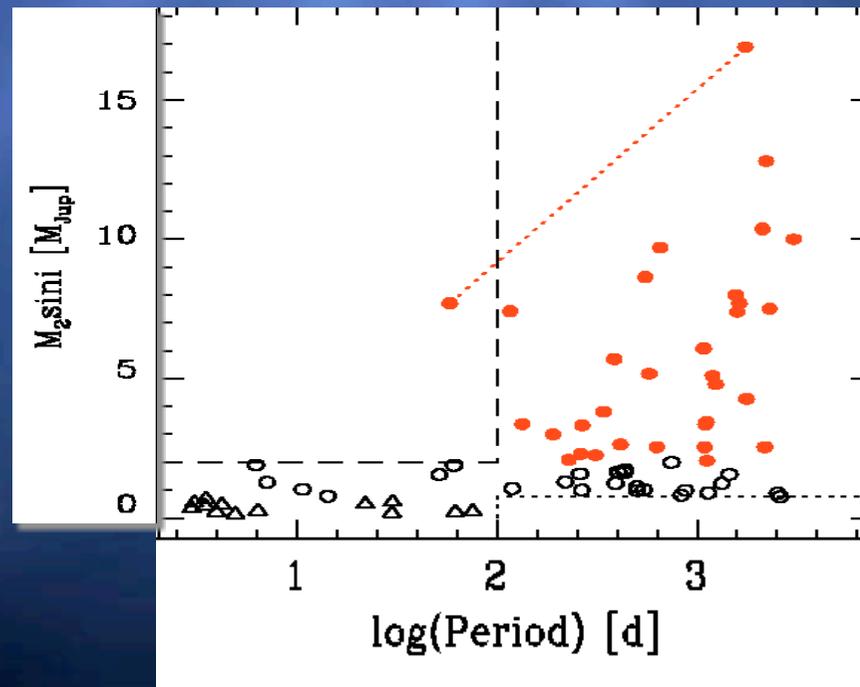
# *The orbits of exo-planets are as eccentric as those of binaries*



- Many short-period, massive planets...

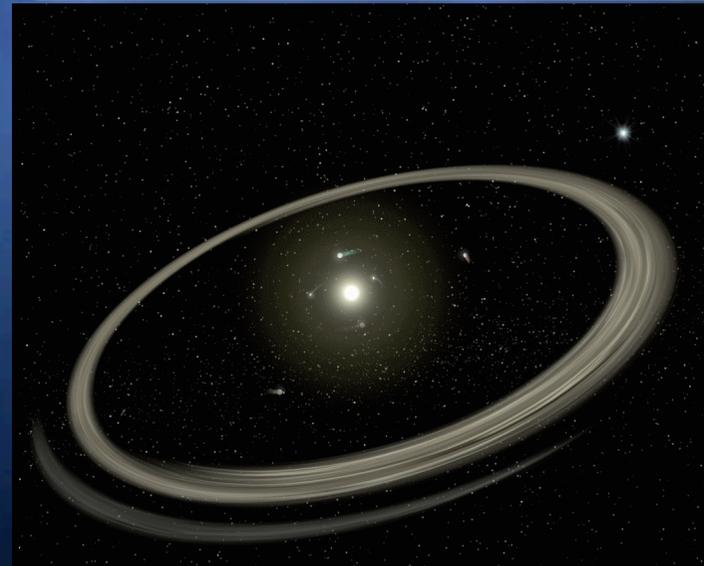
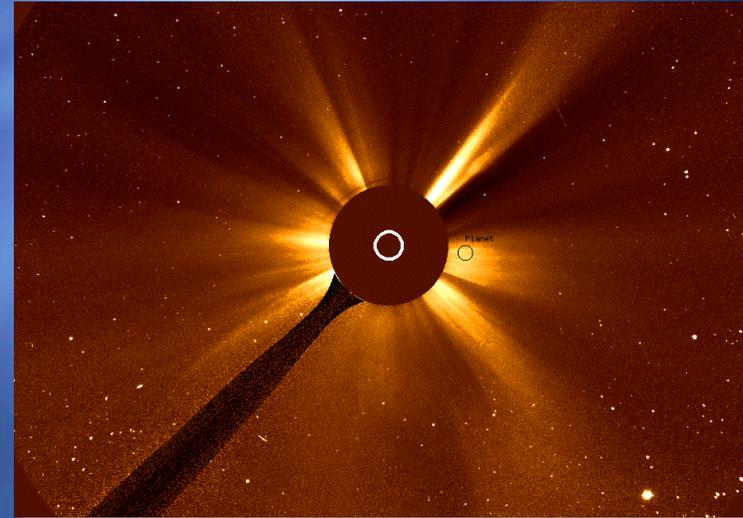


- ..but, a lack of very massive ones



# *Planets of young stars*

- ⊕ Do massive close-in planets never form, or are they destroyed within the first 10-100 Myrs (planets without B-fields evaporate, planets with B-fields not) ?
- ⊕ Was the frequency of planets originally much higher?
- ⊕ Studying interaction of planets and disks



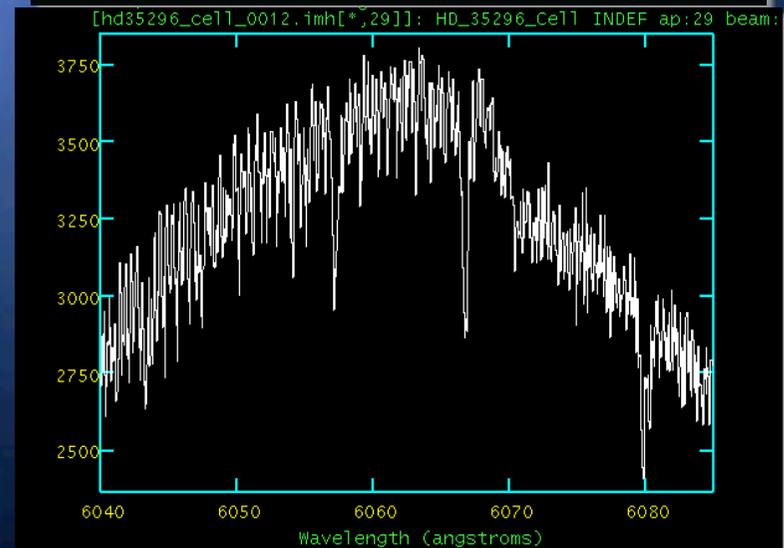
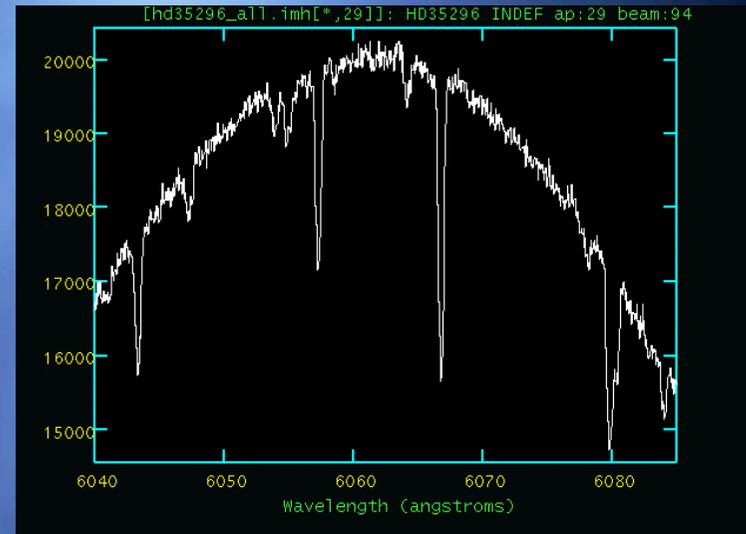
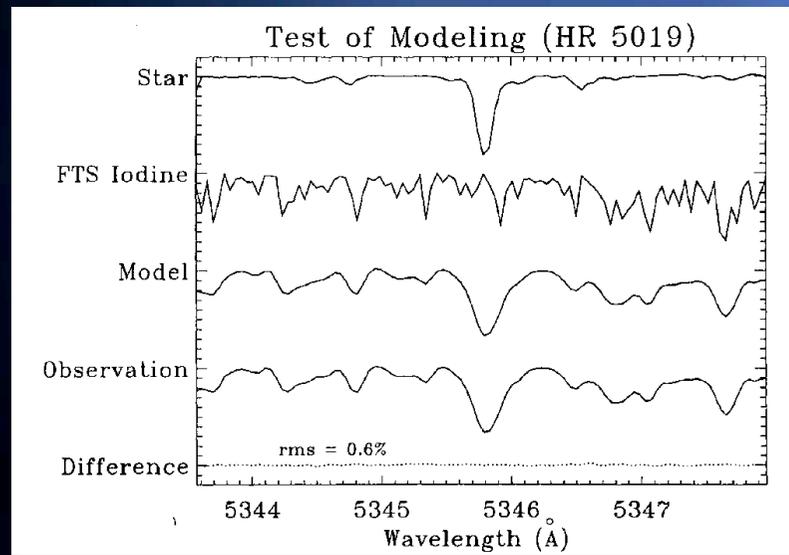
# Planet-planet interaction might play an important role in shaping planetary systems

Weidenschilling & Marzari 1996 Nature 384, 19

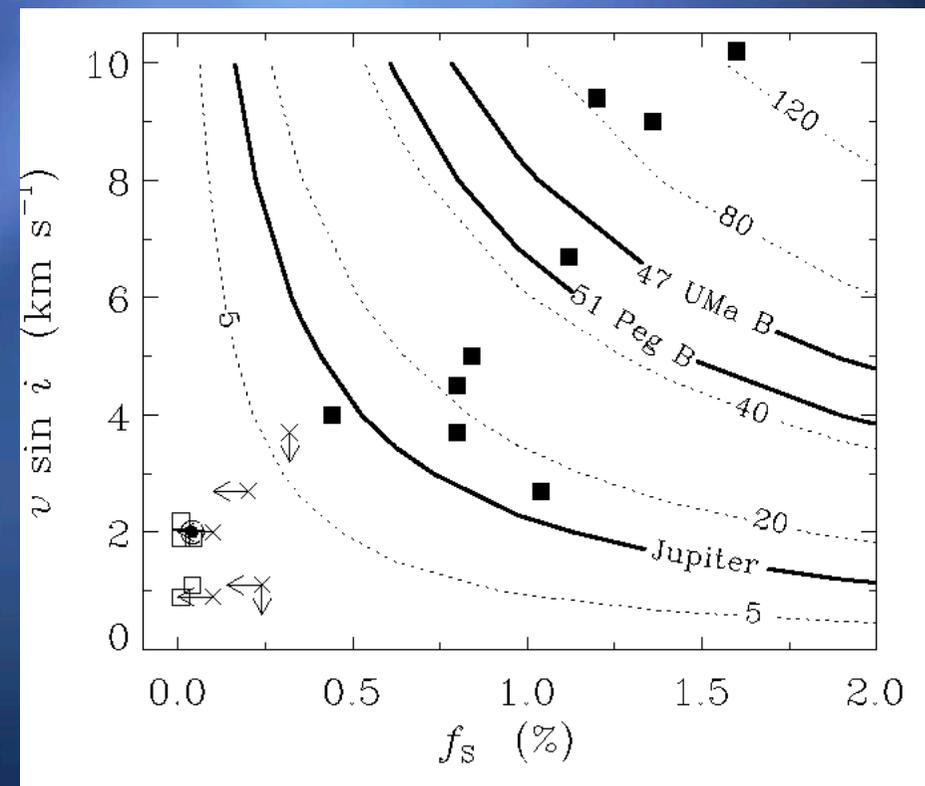
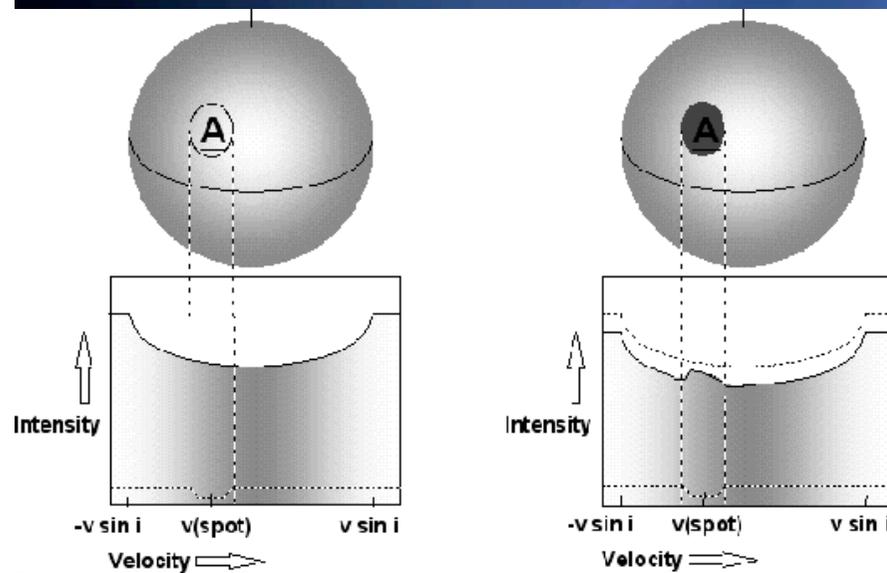


# Precise RV-measurements using the iodine cell

$$I_{\text{obs}}(\lambda) = k[I_s(\lambda + \Delta\lambda_s)T_{\text{I}_2}(\lambda + \Delta\lambda_{\text{I}_2})] \otimes \text{PSF}.$$

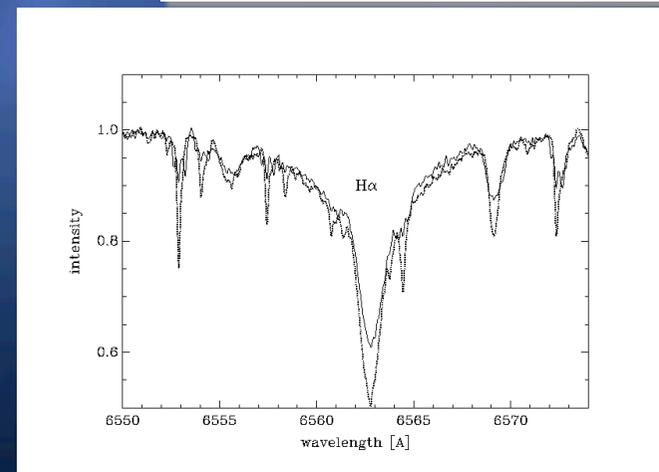
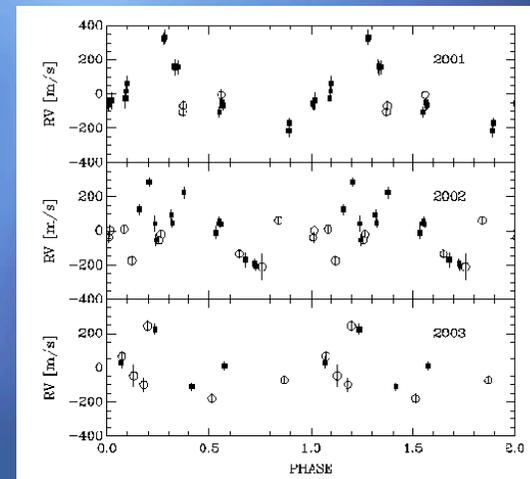


# Young stars are active and spots cause $RV$ -variations

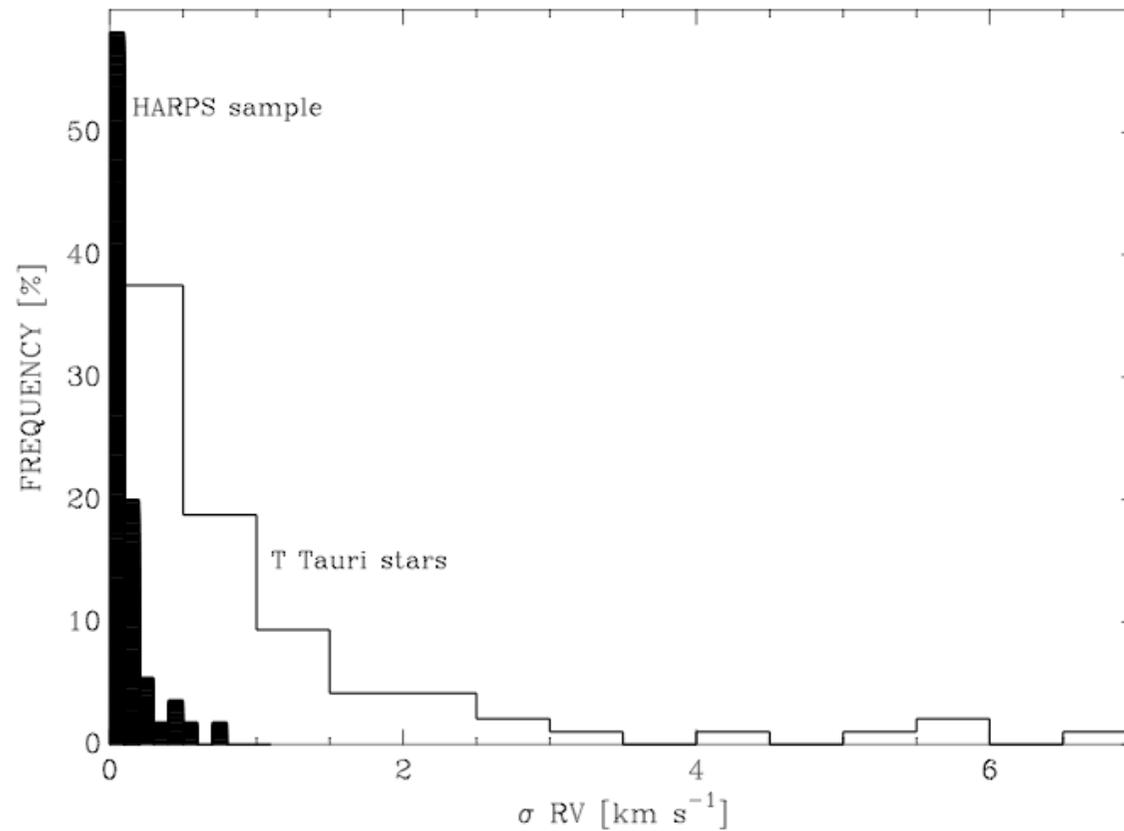


# *How can we distinguish planets and activity?*

- ⊕ Spots change in time: long time basis
- ⊕ Bisectors
- ⊕ CaH, K, and other chromospheric lines
- ⊕ photometry



# *How active are the stars?*

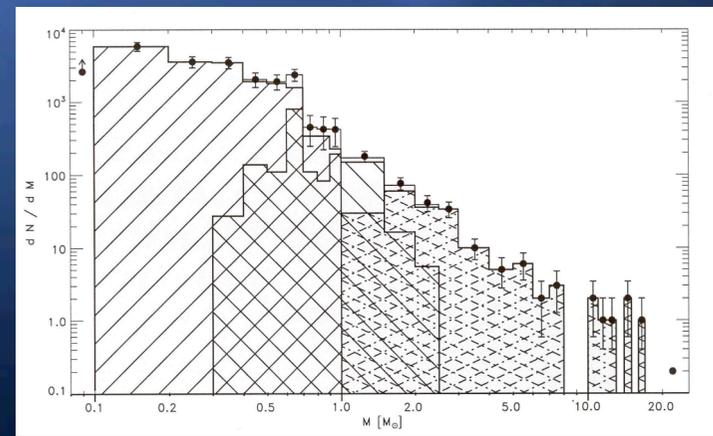
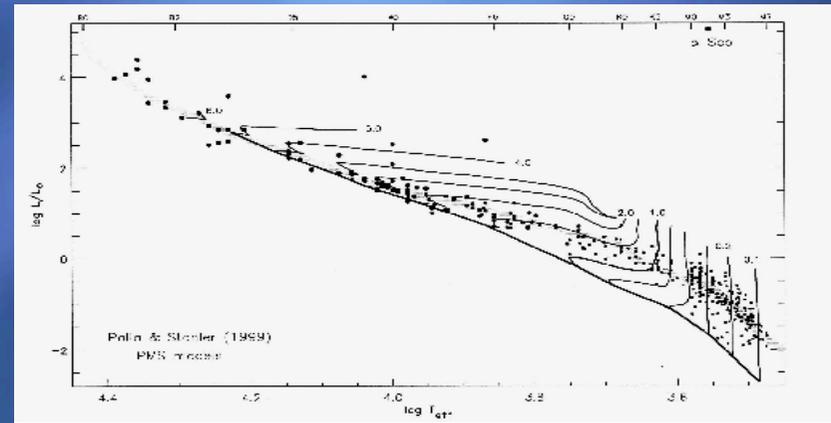
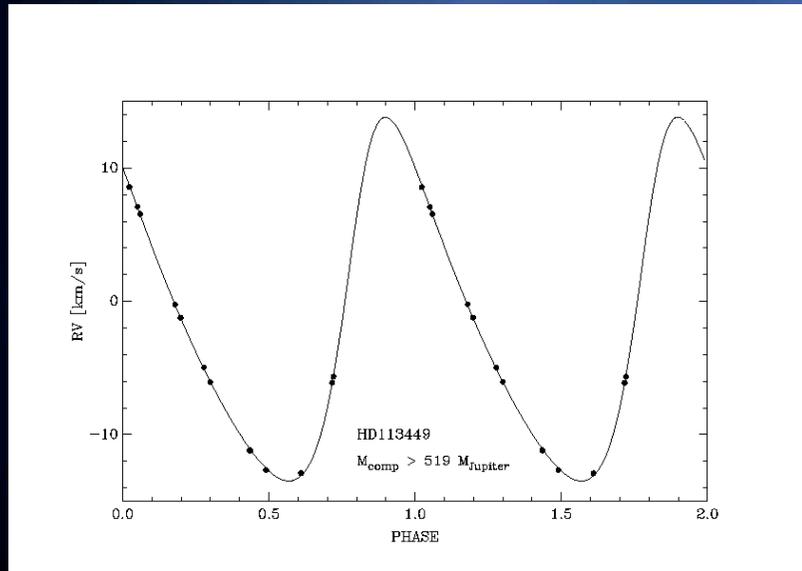


# ***HARPS survey***

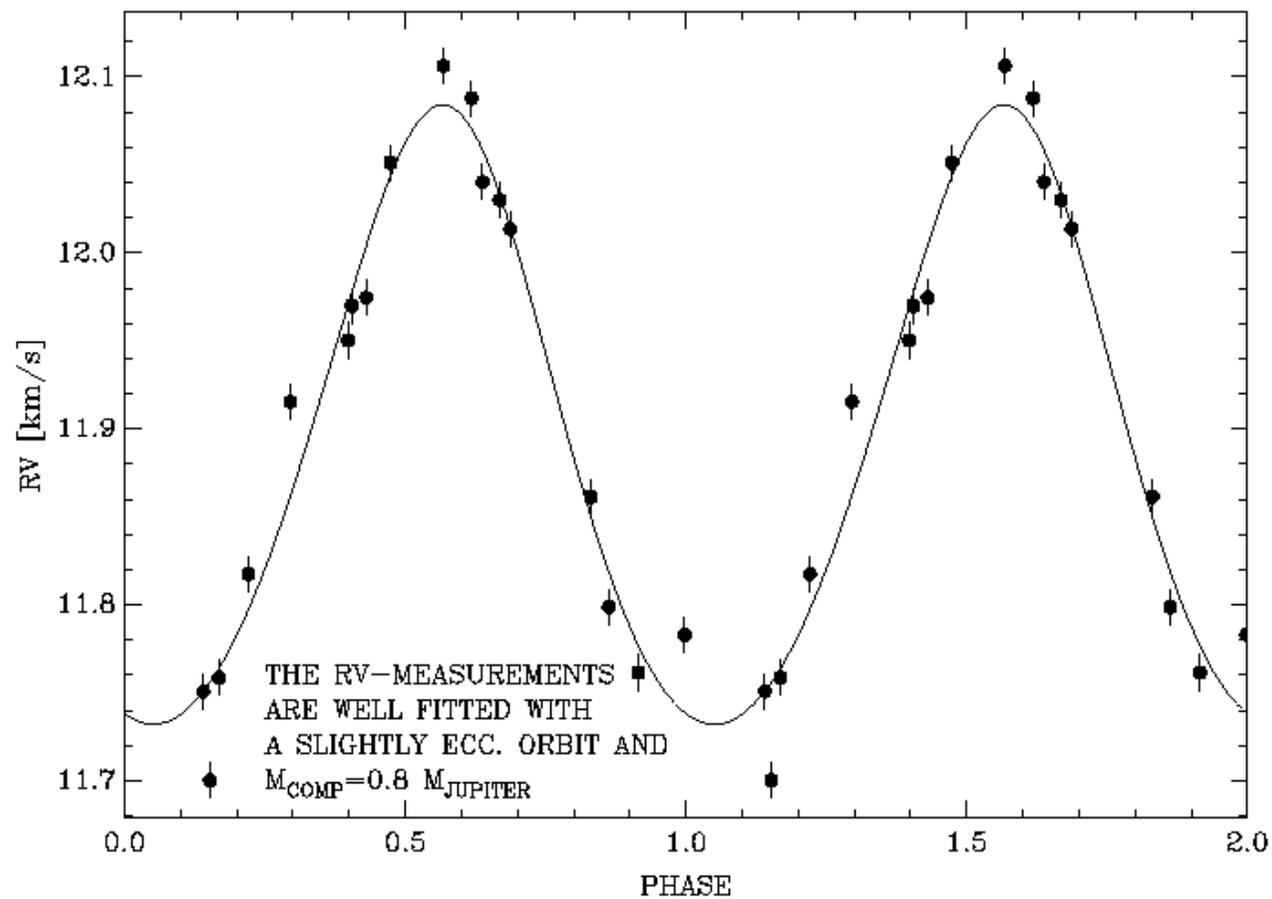
- ⊕ Age 10..100 Myr  
(TW Hydra, beta Pic,  
Horologium, Tucana,  
IC2391)
- ⊕ 85 stars
- ⊕ SpecTyp G,K,M
- ⊕ 800 spectra
- ⊕ Ongoing since 2004



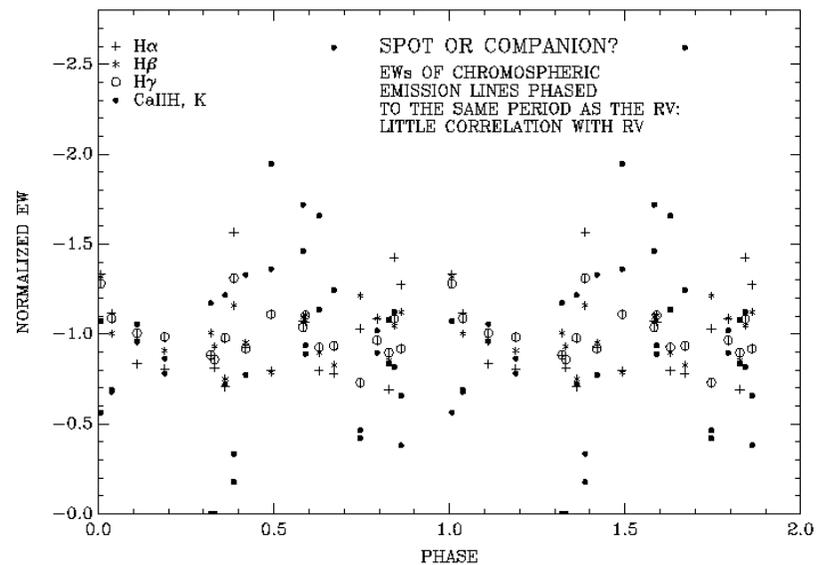
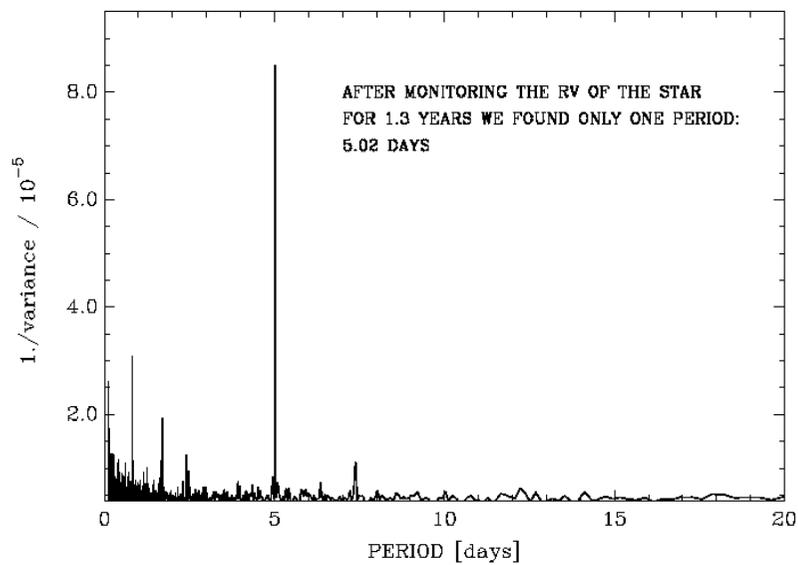
# *A spin off: binaries for testing the evolutionary tracks with the VLTI*



# Planets (candidates) I



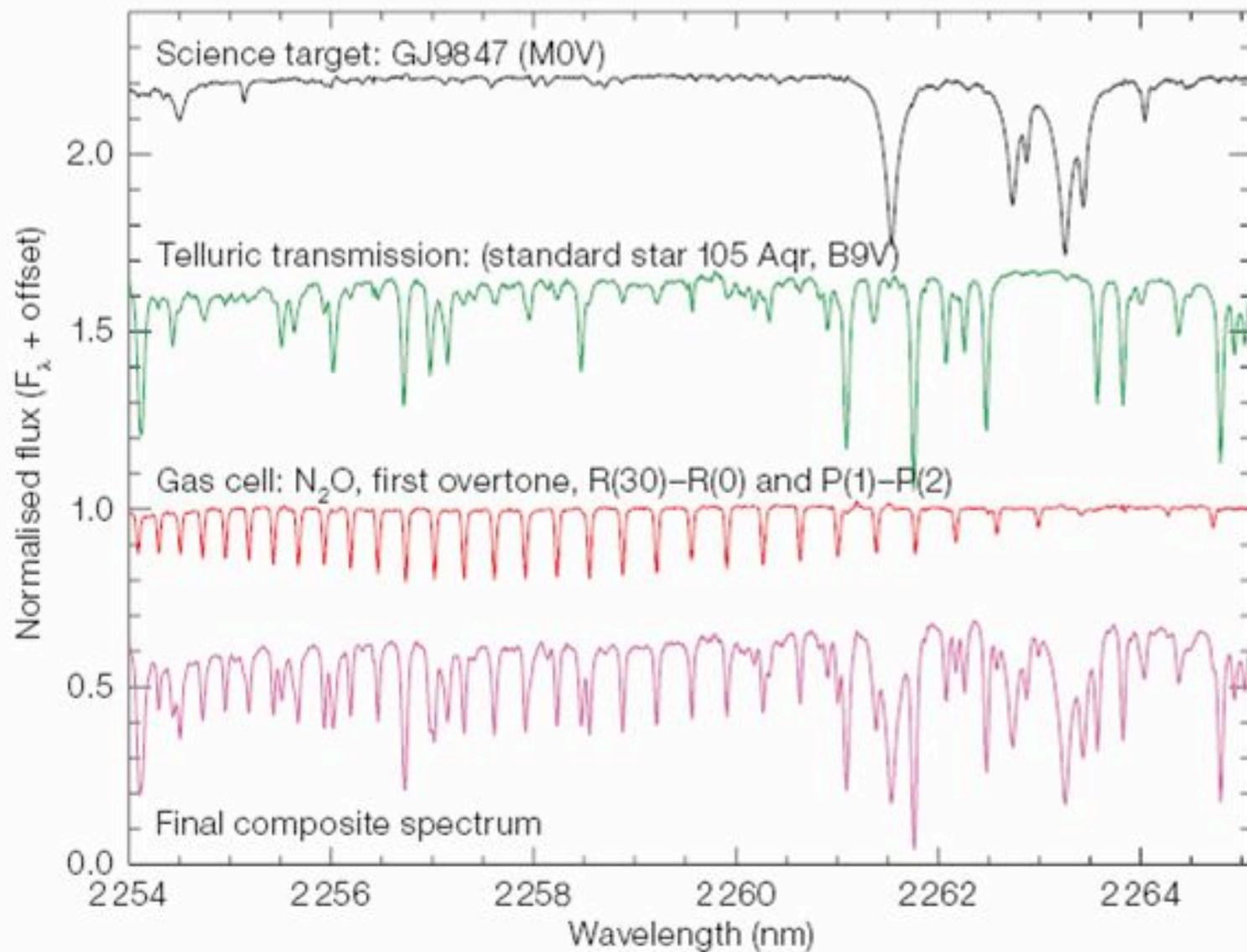
# Planets (candidates) II



## ***Be careful !!!***

Young stars are active, from the fact that all the data phases up one should not conclude that this is a planet!

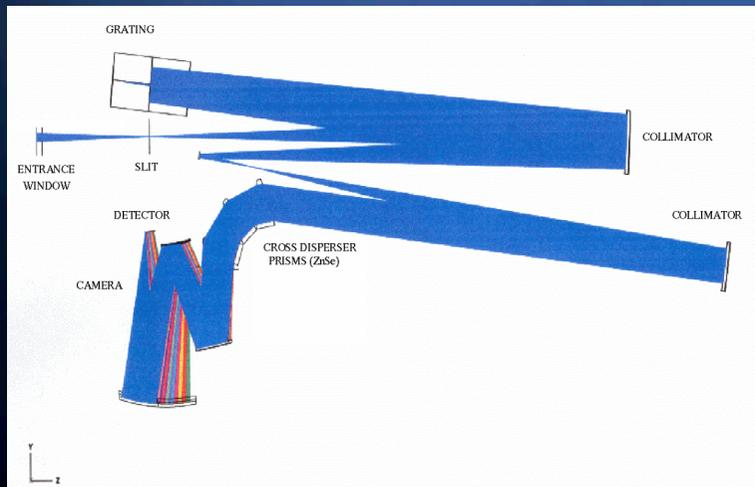
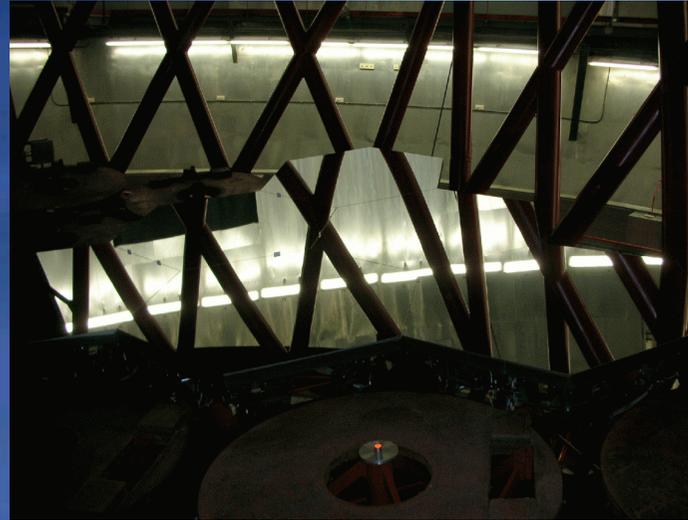
- What we do now : photometry with REM
- Spectroscopy with CRIRES (RV caused by activity depends on wavelength)



# ***Results HARPS survey:***

- ⊕ Sample: 85 stars (originally 92 but 7 are not young)
- ⊕ About 800 spectra taken
- ⊕ Age  $10^7$ - $10^8$  yrs
- ⊕ 5 SBs
- ⊕ 3 planet candidates
- ⊕ For 19 stars we can exclude  $M > 1M_J$  and periods  $> 10$  days.
- ⊕ For 8 additional ones we can exclude  $M > 5M_j$  and periods  $> 10$ days

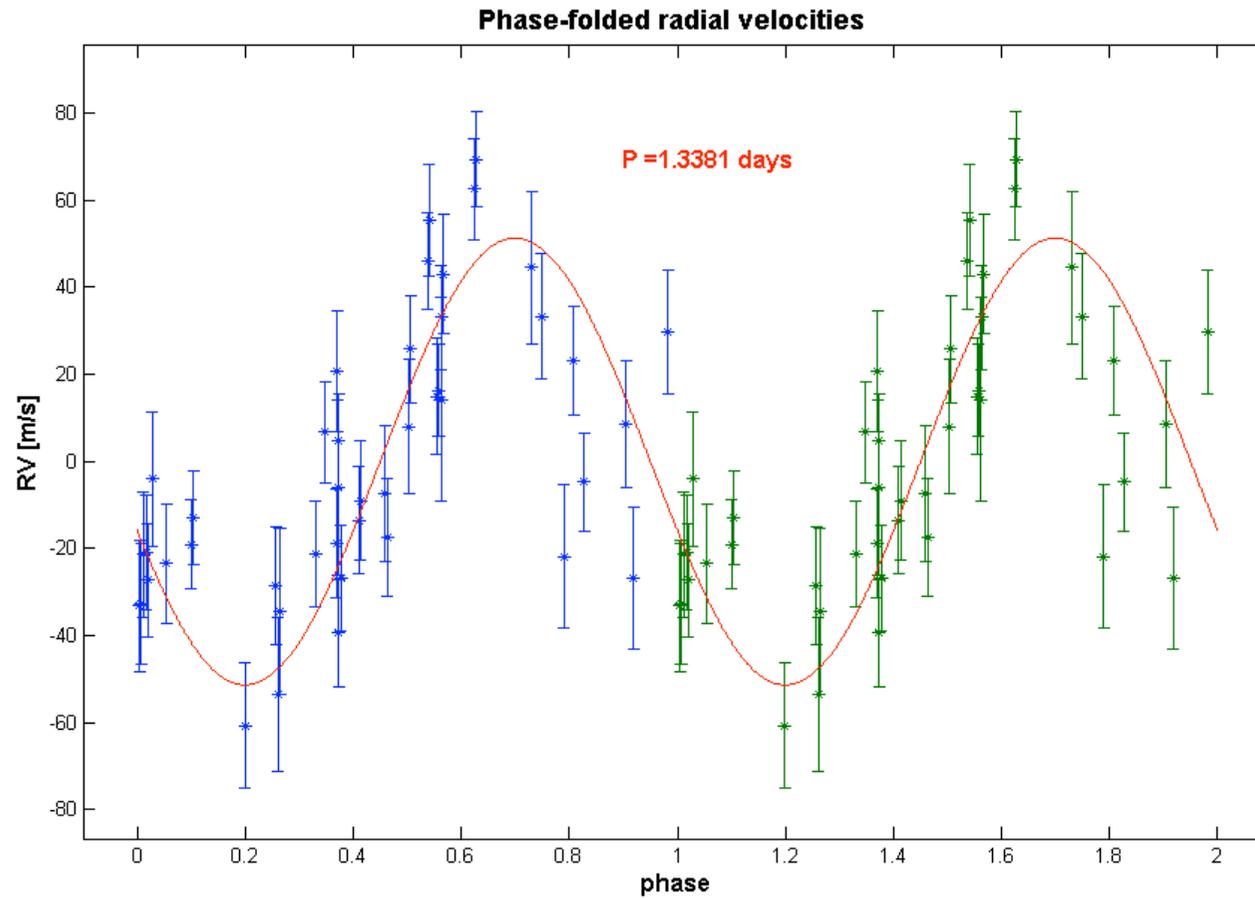
# *Next big step: NAHUAL*



# ***TLS survey:***

- ⊕ Testbed for HARPS survey
- ⊕ Started already in 6 February 2001
- ⊕ Sample: 46 stars (one F star, rest G,K)  
(loads of stars removed because they were all rubbish (not young) !!!)

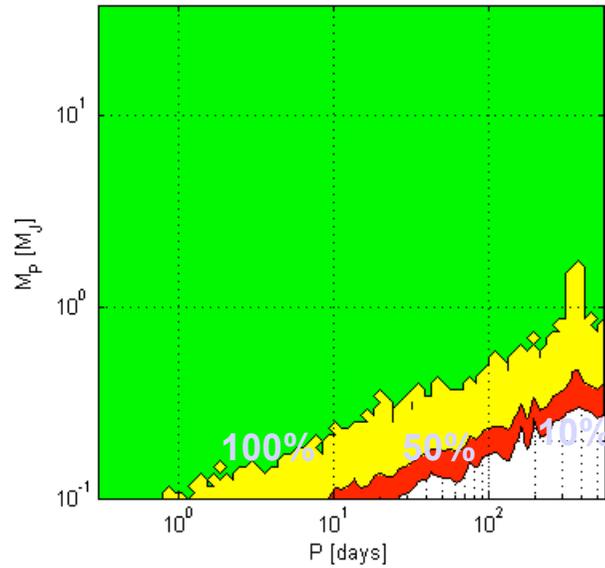
# THIS IS NOT A PLANET!



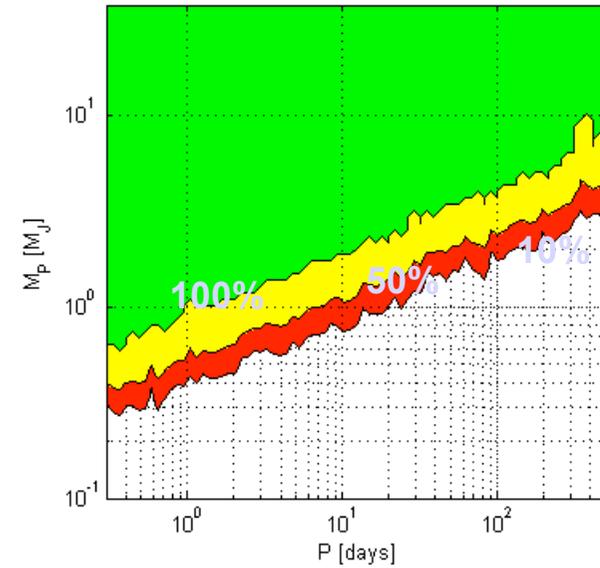
**$K = 51.3 \text{ m/s}$  ;  $e @ 0$  ;  $M P \sin(i) = 0.30 \text{ MJ}$  ;  $a = 0.024 \text{ AU}$**

# Detection limits: a few examples

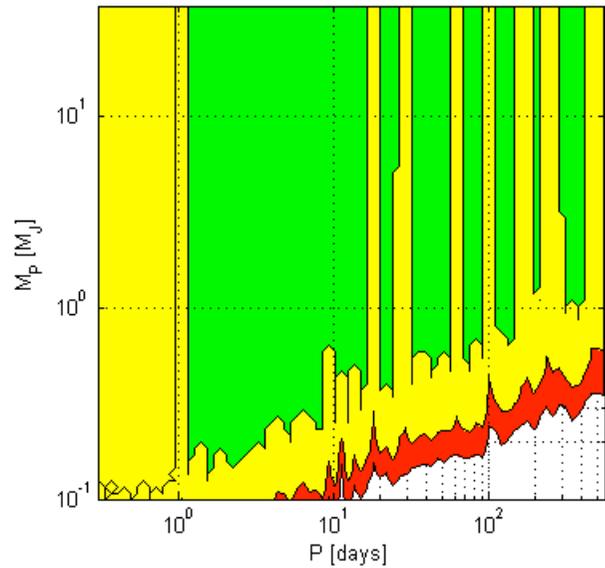
$\sigma_{RV} = 14.4 \text{ m/s}$   $N_p = 48$



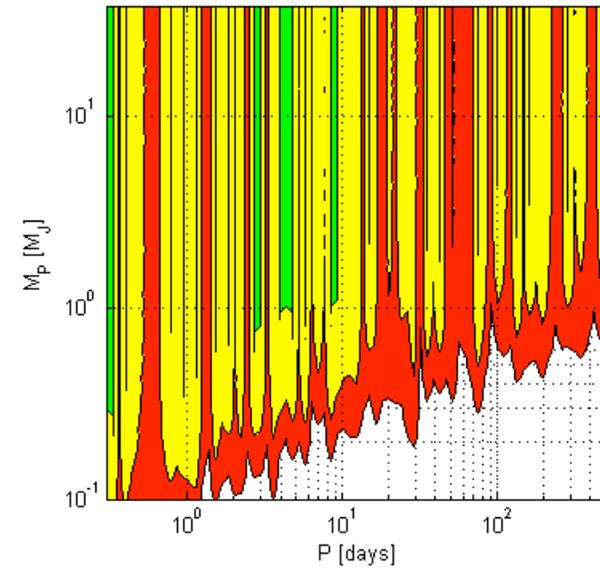
$\sigma_{RV} = 139 \text{ m/s}$   $N_p = 68$

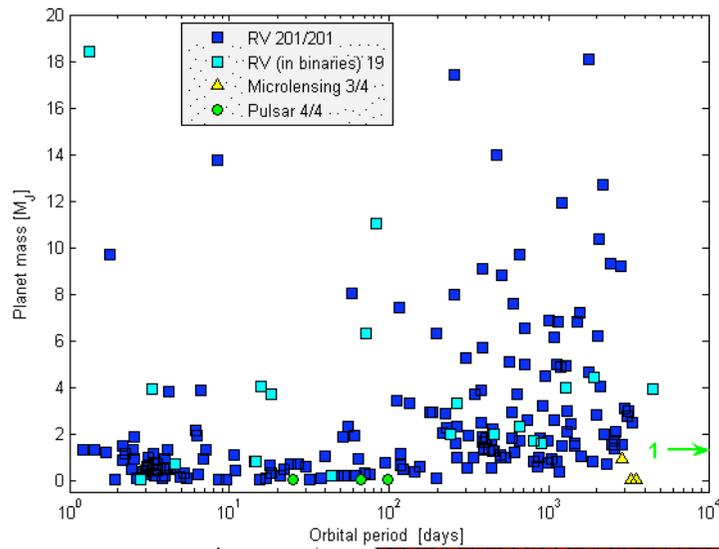


$\sigma_{RV} = 11.3 \text{ m/s}$   $N_p = 20$



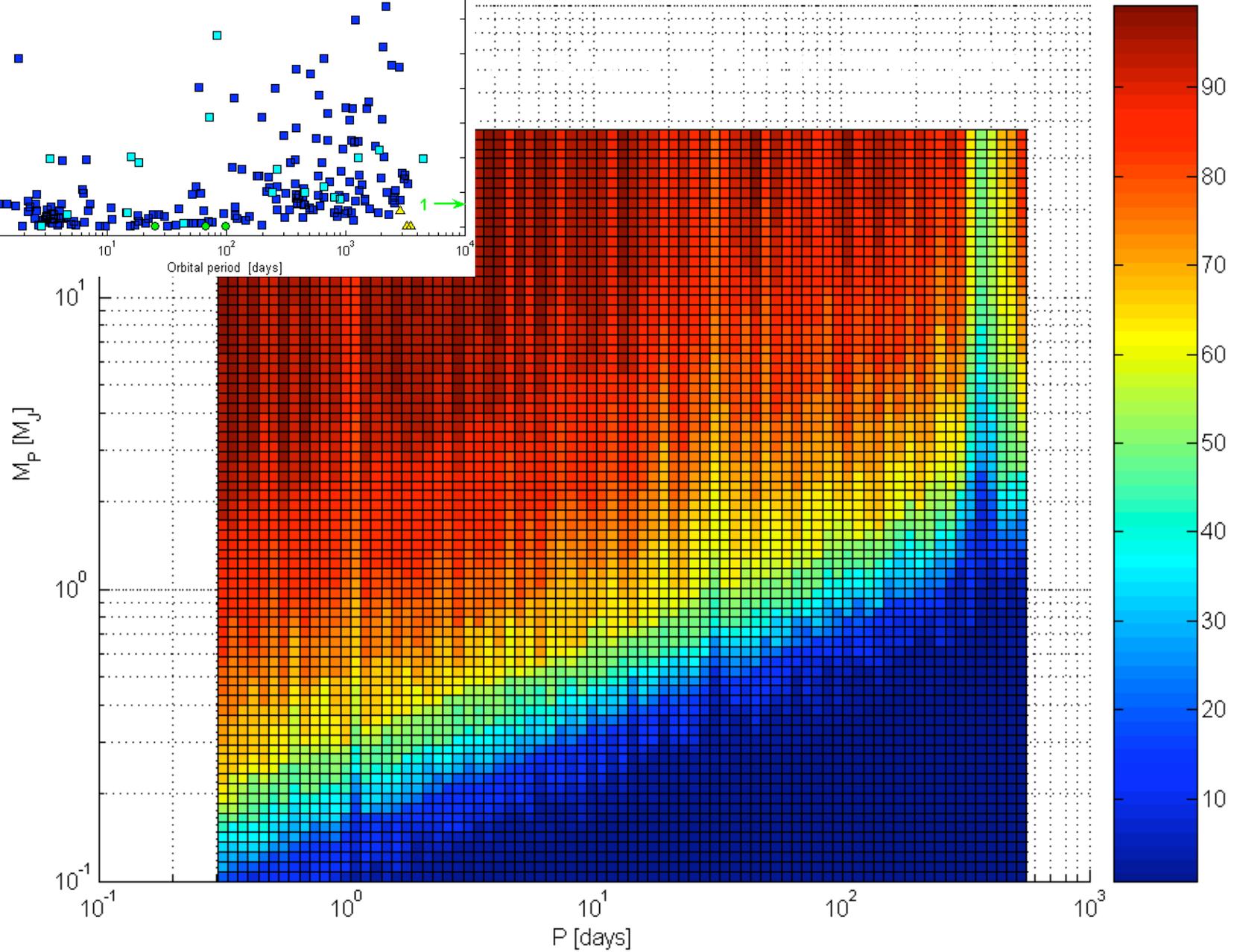
$\sigma_{RV} = 10.5 \text{ m/s}$   $N_p = 10$





Detection limits: results

35 stars



# ***TLS survey:***

- ⊕ 8 SBs
- ⊕ 0 planets
- ⊕ For 80% of the stars we can exclude  $M > 2M_J$  and period  $> 10$  days.
- ⊕ For 95% of the stars we can exclude  $M > 7M_J$  for periods  $< 10$  days

# ***Conclusions***

**→ The frequency of close-in, massive planets of stars with an age of 10 to 100 Myr is about the same as that of old stars.**

**--> Very massive, close-in planets were not destroyed in the age bewtten 10 and 100 Myr but were either destroyed at an earlier age, or never formed.**