

# Star-planet interaction

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7 years in Chile: The Accomplishments and Goals of Czech Astronomers at ESO



## Hot Jupiters

- ▶ close-in Jupiter-like exoplanets
- ▶ orbital distance  $< 0.1$  AU
- ▶ 20% of all exoplanets

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## Star influencing the close-in planet

- ▶ intense X-ray and EUV radiation heat the exospheres of Hot Jupiters  $\rightarrow$  the evaporation of planetary atmosphere (Lammer et al. 2003)
- ▶ increase in the planetary radius; impact on the evolution of the planet (Baraffe et al. 2004)

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- ▶ magnetic interaction
  - ▶ recurring chromospheric emission connected with the planetary orbit
  - ▶ reconnection of field lines from the planet and the star
- ▶ tidal interaction
  - ▶ sustaining faster stellar rotation, activity (Poppenhaeger et al. 2014)

# Search for the star-planet interaction

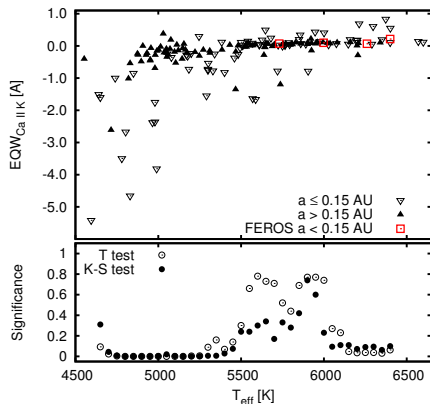
- ▶ search in individual systems
  - ▶ activity in CaII H and K lines (Shkolnik et al. 2003, 2008)
  - ▶ X-ray and EUV observations (Poppenhaeger et al. 2010)
- ▶ statistical studies on selected stellar samples
  - ▶ correlation between the stellar activity and planetary parameters (Knutson et al. 2010, Hartmann 2010)

- ▶ 210 stars with exoplanets
- ▶ Keck HIRES spectrograph archive
  - ▶ echelle spectrograph, resolution of up to 85 000
- ▶ 2.2 m ESO/MPG telescope, instrument FEROS (period 85)
  - ▶ echelle spectrograph, resolution 48 000
- ▶ we measured the equivalent width (EQW) of the central reversal in the core of Ca II K from all spectra (3933 Å)

# Statistical tests

## Temperature vs. Equivalent width

- ▶ the sample was divided into two groups (Bodenheimer et al. 2001)
  - $a \leq 0.15$  AU
  - $a > 0.15$  AU
- ▶ Kolmogorov-Smirnov test and Student's  $t$ -test were performed
  - ▶ running window – 400 K wide and runs along the temperature axis in steps of 50 K

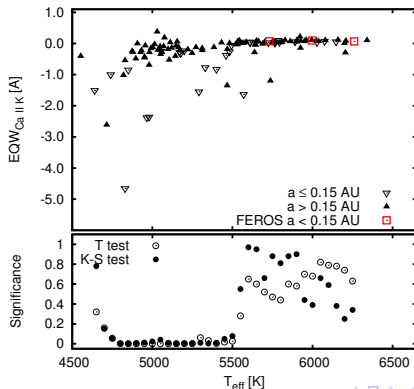




# Statistical tests

Restricted sample; Temperature vs. Equivalent width

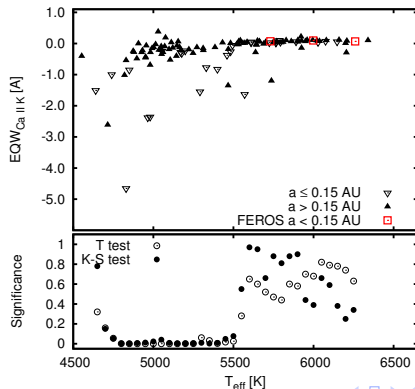
- ▶ bias in the sample – exoplanets discovered by radial velocity method orbit generally low-activity stars



# Statistical tests

Restricted sample; Temperature vs. Equivalent width

- ▶ cool stars ( $T_{\text{eff}} \leq 5500$  K) with close-in planets ( $a \leq 0.15$  AU) generally have higher Ca II K emission than stars with more distant planets (Krejčová & Budaj 2012)



# Conclusion

- ▶ long term monitoring of exoplanetary systems
- ▶ eliminating the biases in the sample of exoplanetary systems

- ▶ Baraffe et al. 2004, A&A, 419, 13
- ▶ Hartmann, J.D. 2010, ApJl, 717, L138
- ▶ Isaacson, H. & Fisher, D. 2010, ApJ, 725, 875
- ▶ Knutson, H.A. et al. 2010, ApJ, 720, 1569
- ▶ Krejčová, T., Budaj, J. 2012, A&A, 540, A82
- ▶ Lammer et al. 2003, ApJ 598, 121
- ▶ Pillitteri, I. et al., 2014, arxiv:1403.1029
- ▶ Poppenhaeger, K. et al. 2010, A&A, 515, A98
- ▶ Poppenhaeger, K., Wolk, S.J., 2014, arXiv:1404.1073
- ▶ Shkolnik et al. 2003, ApJ, 597, 1092
- ▶ Shkolnik et al. 2008, ApJ, 676, 628
- ▶ Wright, J.T. et al. 2004, ApJS, 152, 261



# Temperature vs. $\log R'_{\text{HK}}$

- ▶ For comparison we used the parameter  $\log R'_{\text{HK}}$  (Wright et al. 2004, Knutson et al. 2010, and Isaacson et al. 2010).
  - ▶ Parameter  $\log R'_{\text{HK}}$  was introduced by Middelkoop (1982) to remove the photospheric component (to remove the dependence on the temperature).
  - ▶ Defined for a range of values:  $0.5 < B - V < 0.8$ .

