Earth-like exoplanet signals hidden by stellar activity

Annelies Mortier

Andrew Collier Cameron and the HARPS-N team

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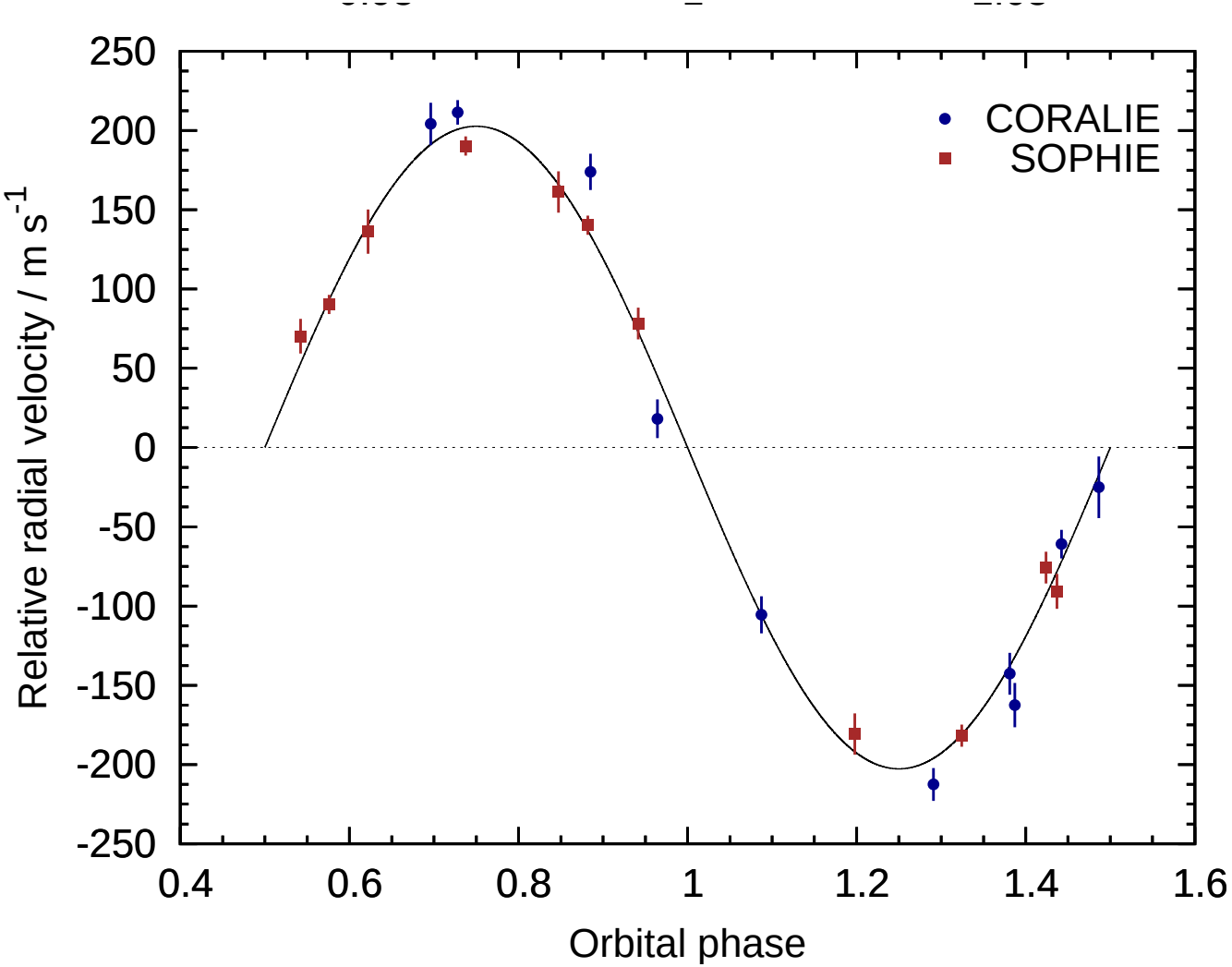
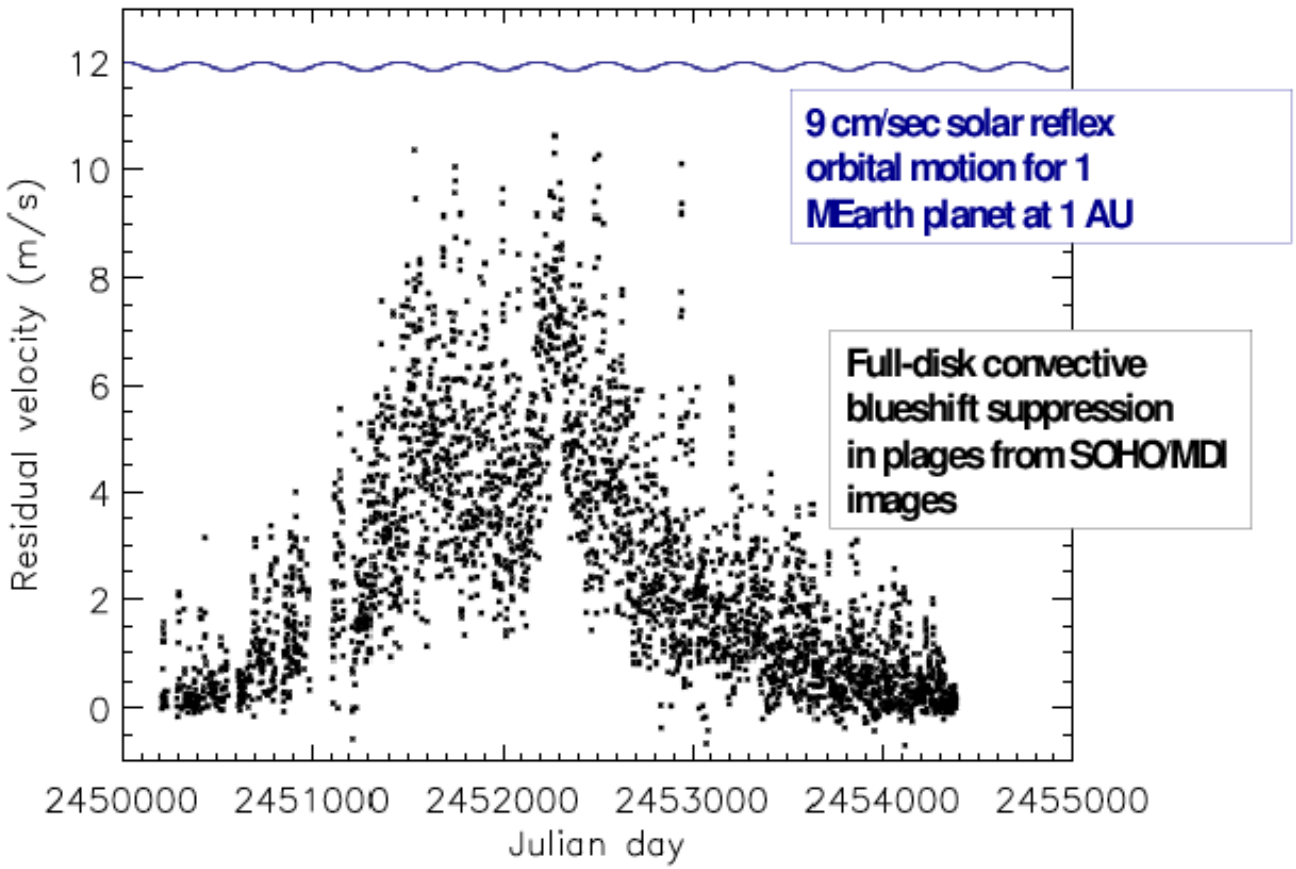
Stellar activity - a little perspective



WASP-104b, Smith et al. 2014

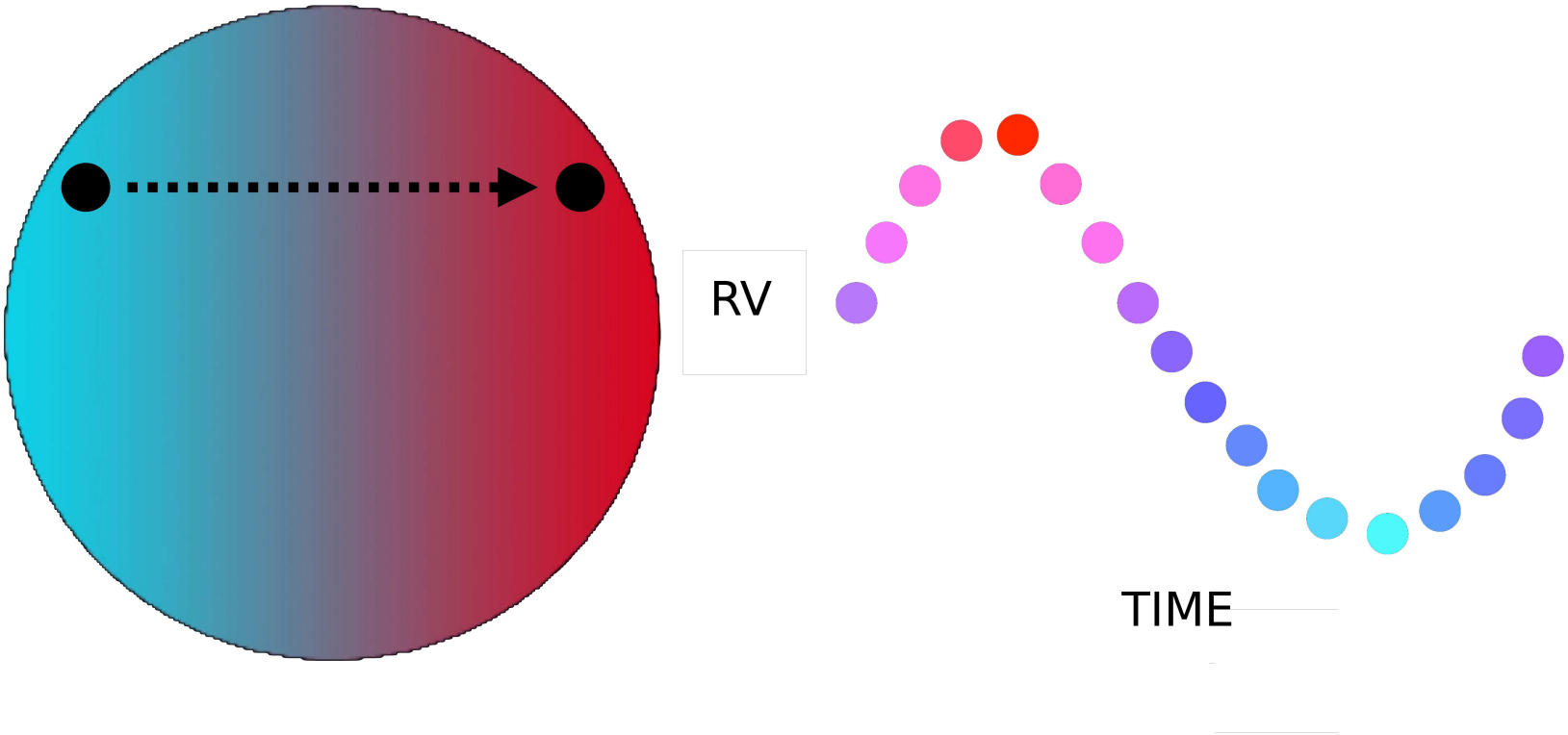
Stellar activity - a little perspective



Meunier et al. 2010

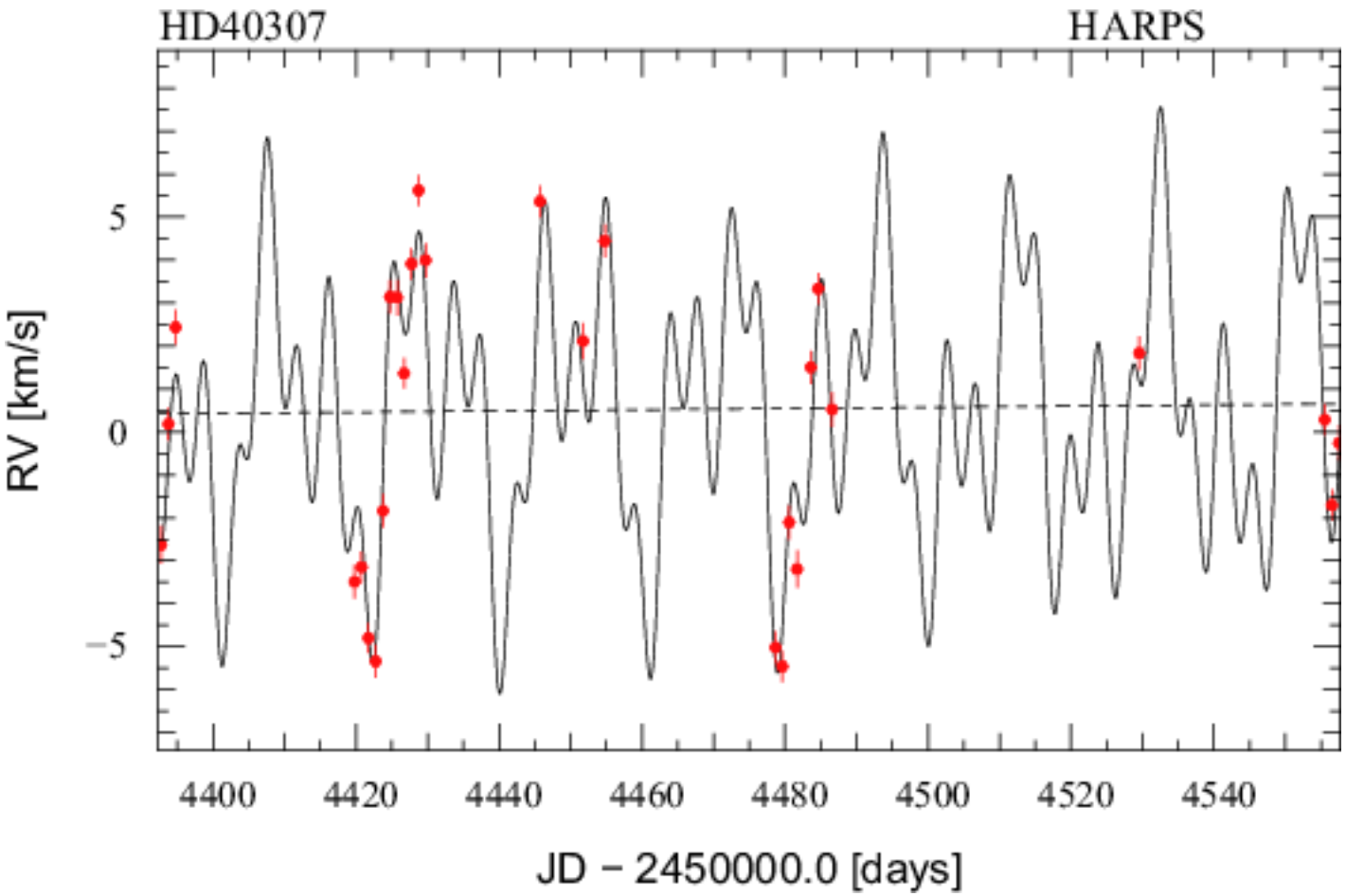
Stellar activity can hide planetary signals

Active regions - stellar rotation effect on RV



Stellar activity can easily mimic a planetary signal
Effect of few m/s on timescales of 10-30 days
Variable active region lifetimes $\Rightarrow$ non-coherent signal
Very hard to correct

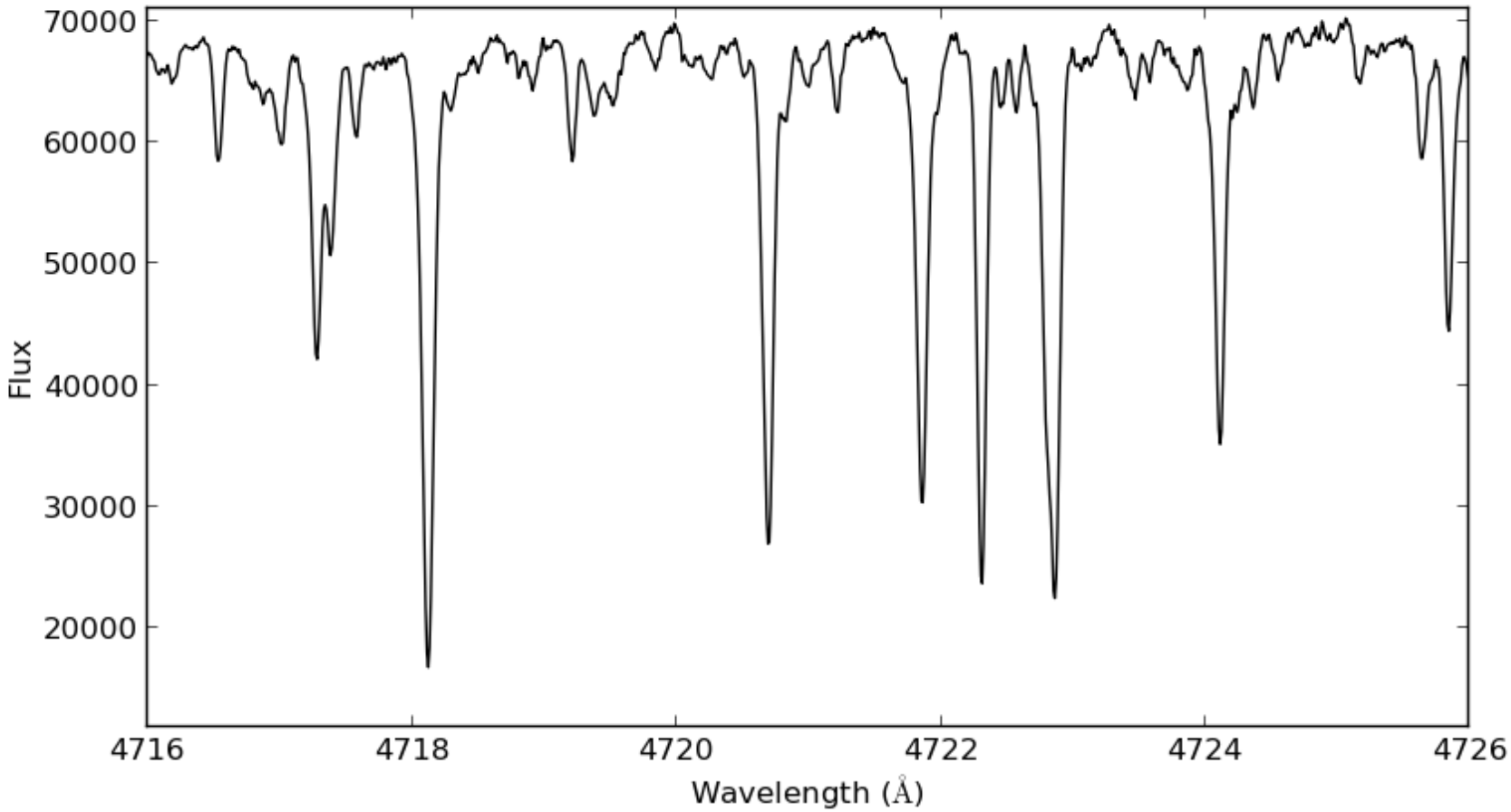
Planetary signal already complicated



Mayor et al. 2009

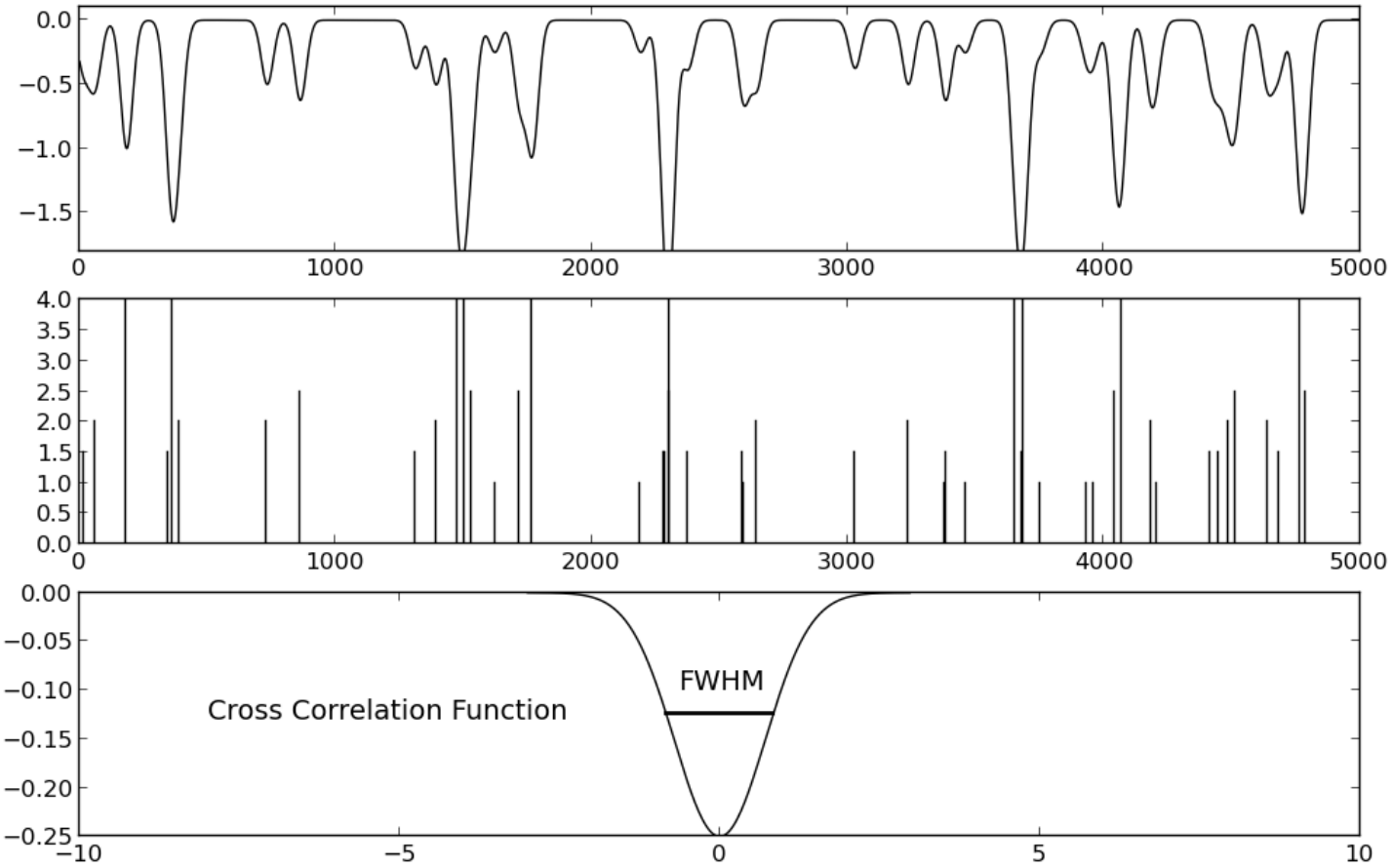
Planetary system creates complicated RV signal

High-resolution spectroscopy



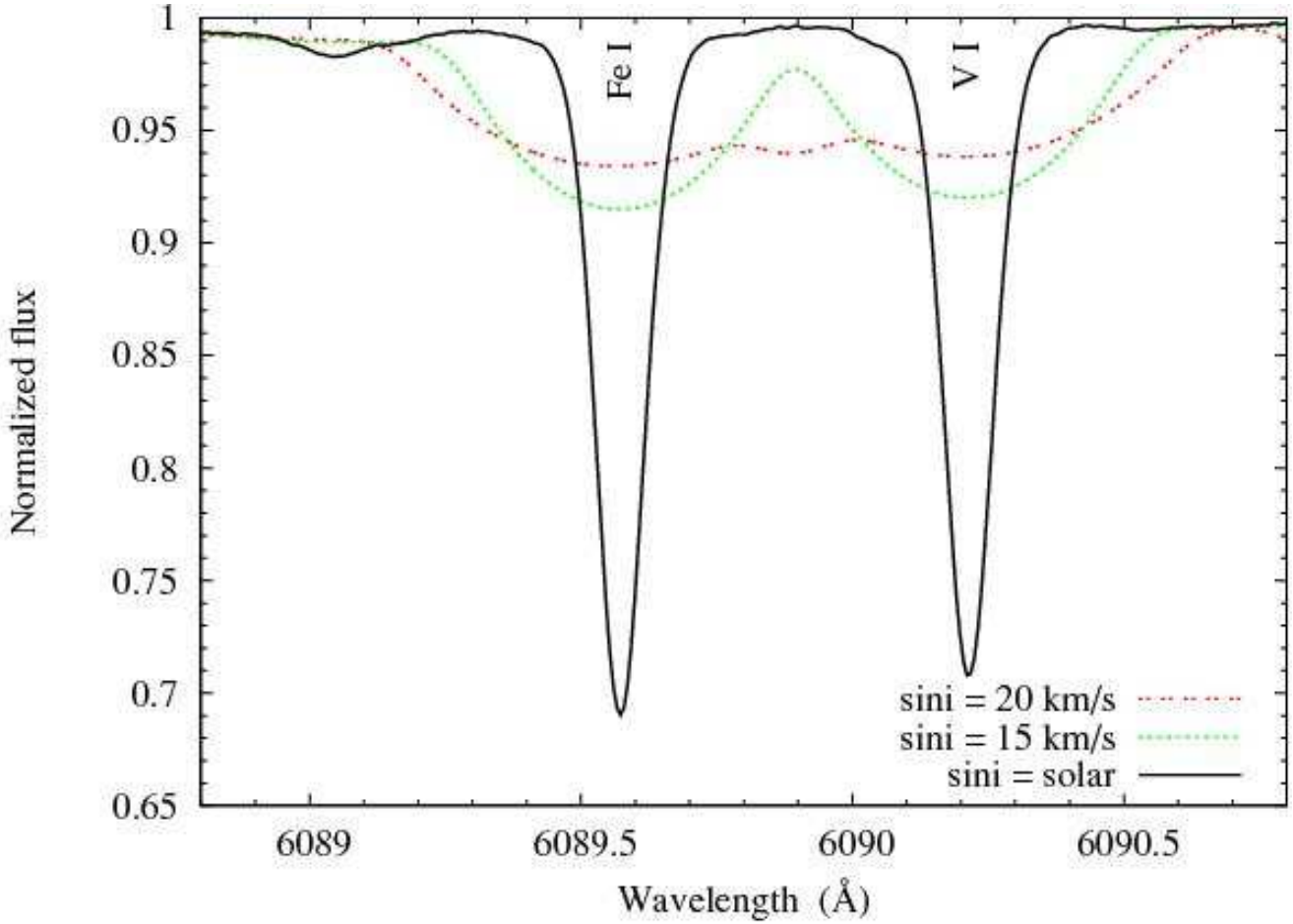
RV searches provide very high-resolution spectra
Thousands of spectral absorption lines

Standard method: Cross Correlation



Fitting the CCF determines the RV and the line shape

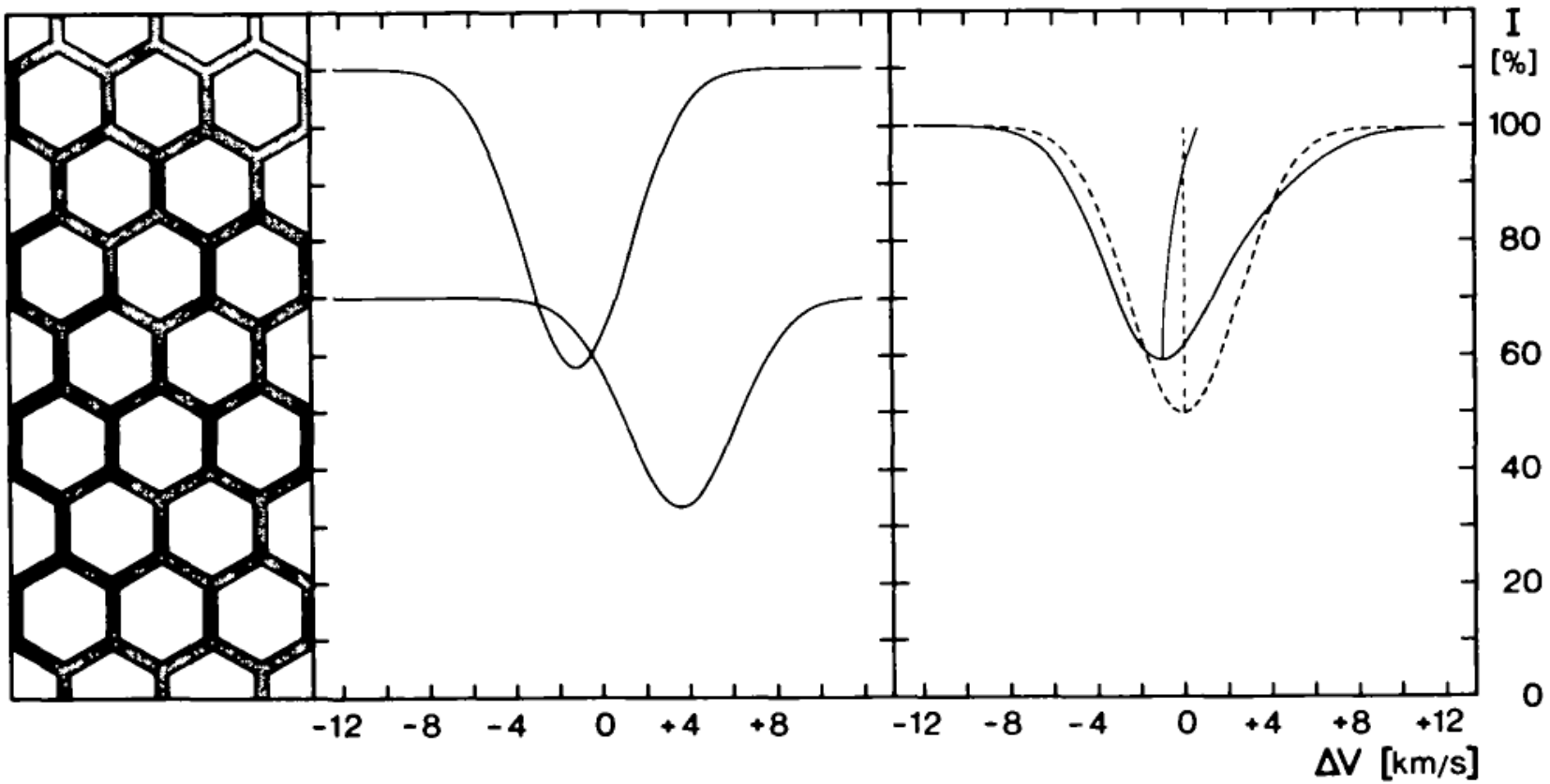
Activity impact on spectral lines: Rotational broadening



Tsantaki et al. 2014

Spectral line broadening / blending by stellar rotation
Slow rotators are preferred in RV searches

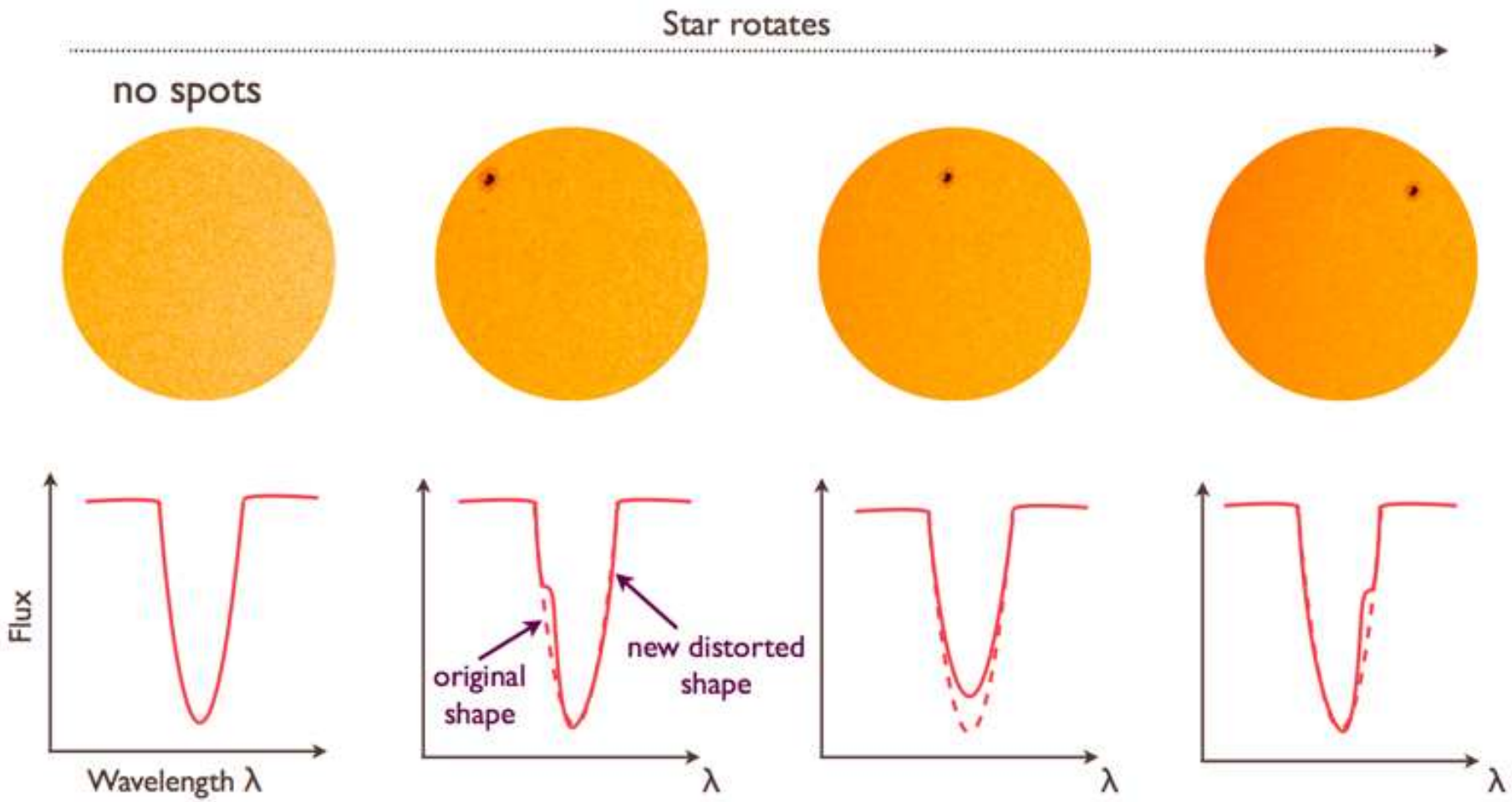
Activity impact on spectral lines



Dravins et al. 1981

Granulation affects the center and shape of the spectral line

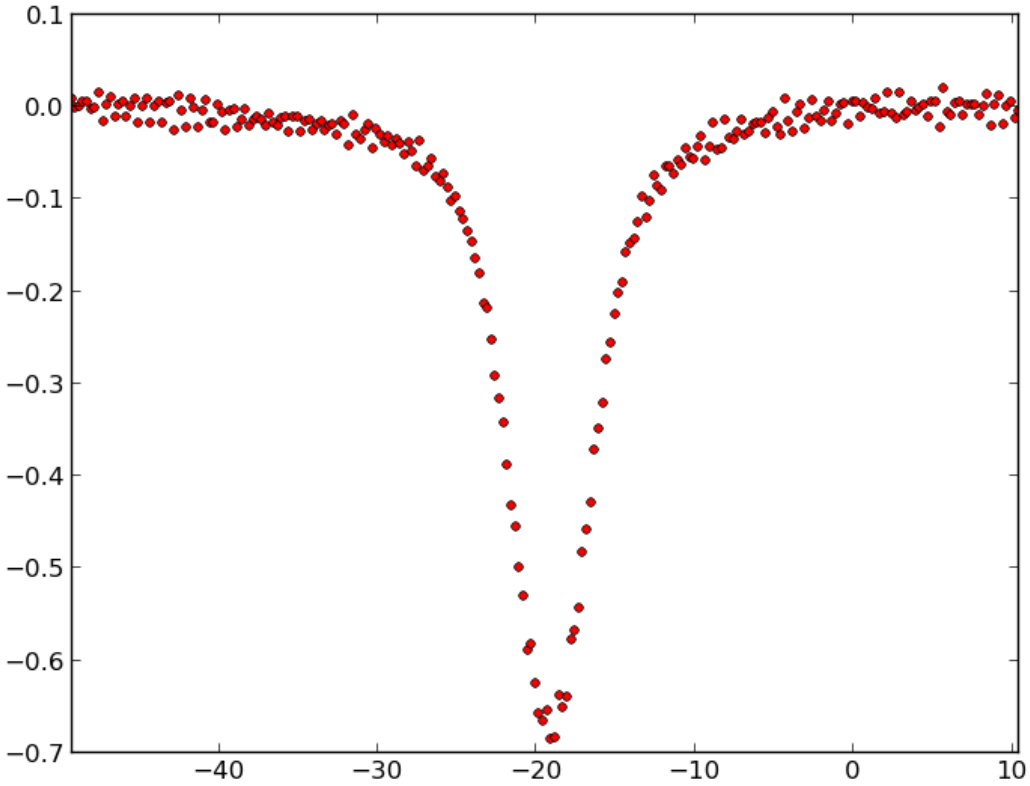
Activity impact on spectral lines



courtesy Raphaëlle Haywood

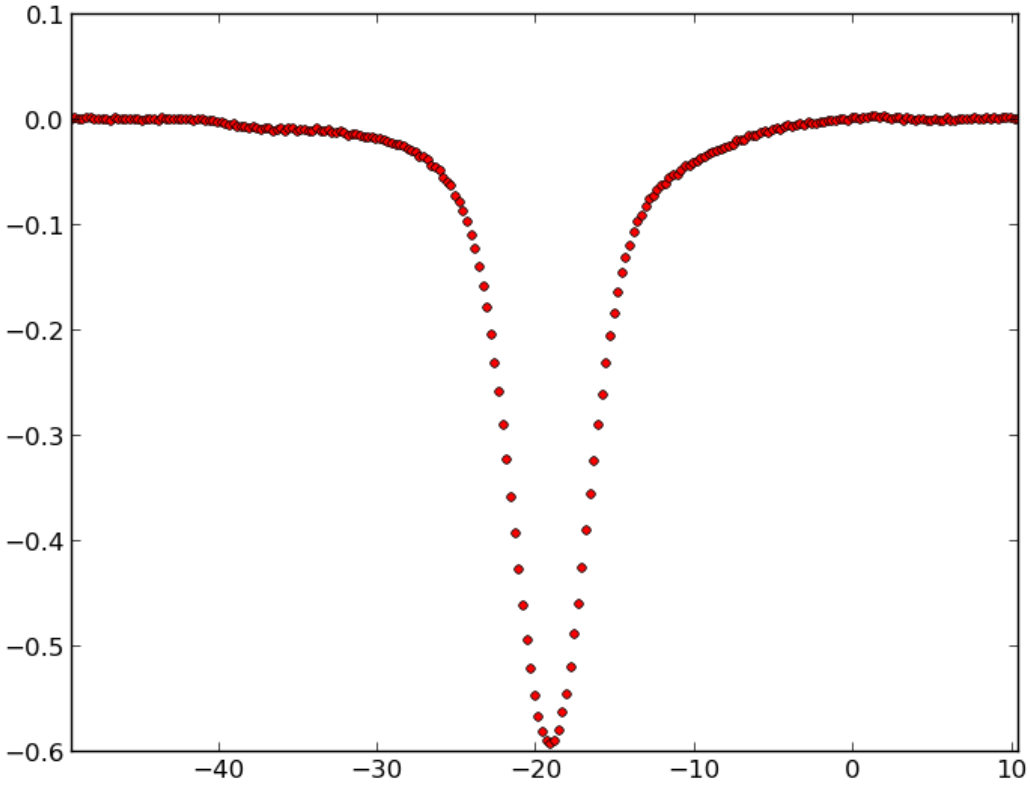
Stellar spots affect the center and shape of the spectral line

LSD profile - white noise only



Least-squares deconvolution method
(e.g. Donati et al. 1997, Collier Cameron et al. 2002)
Derive not only the RV but also line properties
Different sets of profiles, line masks and weights can be incorporated.

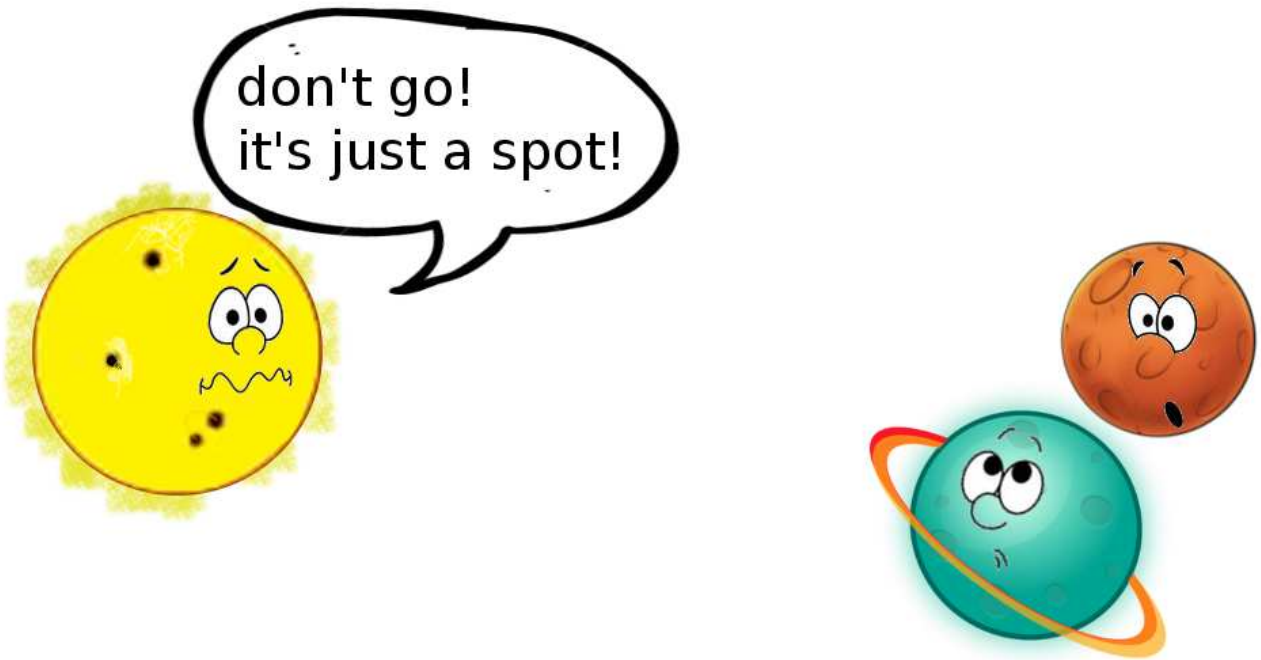
LSD profile - white + red noise



Use a Gaussian process to allow sub-pixel sampling
Take into account original pixel spacing ⇒ Red noise

Conclusions

- You need to know your star to know your planet
- RV studies provide high-resolution spectra of the star
- New LSD algorithm includes red noise and can model different layers of the stellar atmosphere
- Planet signals are coherent and periodic



Courtesy: João Faria