Earth-like exoplanet signals hidden by stellar activity

Annelies Mortier
Andrew Collier Cameron and the HARPS-N team

UK Community Exoplanet Conference

30 March 2015, Warwick

Supported by FP7 - ETA-Earth
Stellar activity - a little perspective

WASP-104b, Smith et al. 2014
Stellar activity can hide planetary signals

Meunier et al. 2010
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 ⇒ non-coherent signal.
Very hard to correct.
Planetary signal already complicated

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

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

Tsantaki et al. 2014
Granulation affects the center and shape of the spectral line

Dravins et al. 1981
Stellar spots affect the center and shape of the spectral line

courtesy Raphaëlle Haywood
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.
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