Simultaneous Magnetic Field and Radial Velocity Measurement

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MOTIVATION

Stellar activity induces radial velocity variations on the meter per second scale impeding the detection of Earth twins.

The stellar surface is permeated by an inhomogeneous time-varying magnetic field interplaying with the stellar convective flows. Tracking the magnetic field allows to estimate the **suppression of convective blueshift** (Haywood et al., 2016, 2020; Milbourne et al., 2019) and therefore the **magnetically induced RV variations**.

STELLAR MAGNETIC FIELD

Due to the **Zeeman effect**, a magnetic field splits absorption lines into several components at different wavelengths. These components exhibit different polarisations.

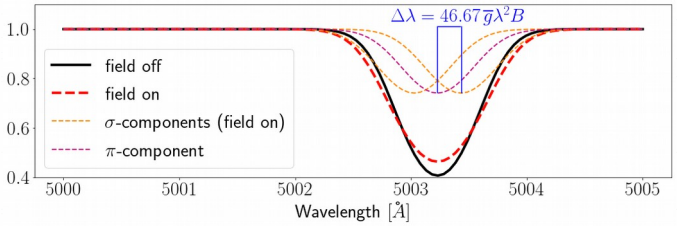

Fig. 1. Zeeman broadening of an idealised absorption line. The shift of the components is proportional to the Landé factor, the wavelength squared, and the magnetic field strength.

TRADITIONAL APPROACH

The magnetic field strength can be estimated from spectropolarimetric measurements. This approach relies on comparing the least-squares deconvolution profile of Stokes V and I spectra (e.g. Donati et al. 1997).

NEW APPROACH

Combining the **least-squares deconvolution** technique with absorption line information, we estimate the **magnetic field changes** from **Stokes I** spectra via the Zeeman effect, which paves the way to a more stable radial velocity measurement.

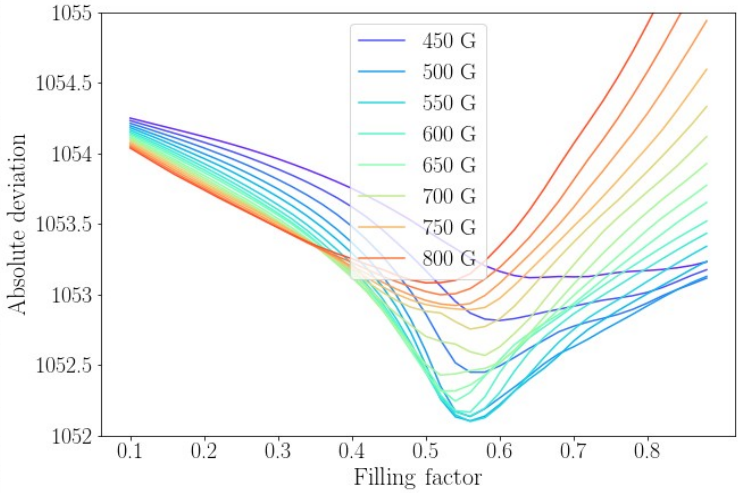

Fig. 2. We divide the stellar surface into a magnetic (filling factor above) and a non-magnetic part and account for Zeeman broadening in the line profiles in the deconvolution process. The least-squares deconvolution model fits the spectrum best where the absolute deviation between them is lowest.

References:

Donati J. F., Semel M., Carter B. D., Rees D. E., Collier Cameron A., 1997, MNRAS, 291, 658
Haywood R. D., et al., 2016, MNRAS, 457, 3637
Milbourne T. W., et al., 2019, ApJ, 874, 107
Haywood R. D., et al., 2020, arXiv:2005.13386

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