Formation temperature-dependent stellar activity RVs across spectral types

Khaled Al Moulla
University of Geneva

Previous studies have demonstrated how spectral lines react differently to stellar activity (Thompson et al. 2017, Dumusque 2018, Wise et al. 2018). Recently, it has been shown that the induced RV depends on line depth and average formation temperature, i.e. measures of the physical depth within the stellar photosphere (Cretignier et al. 2020, Al Moulla et al. 2022), in agreement with our current understanding of convective motion in the envelopes of late-type stars. These studies have primarily focused on well-sampled, high-SNR (>500 for nightly binned spectra) targets such as the Sun or alpha Cen B. Here, we present an extended analysis of the temperature-dependent stellar RVs on a sample of 20 G to M stars observed in high resolution (R~115,000) with the HARPS and HARPS-N spectrographs. By doing so, we aim at investigating differences and trends with spectral type, but also the applicability of the method to cadences and SNR levels of more typical stellar measurements. We find that by synthesising the spectra on a star-by-star basis, we are able to make a careful selection of well-modelled spectral lines. The convective blueshift of the core of these lines demonstrate a linear relation with their derived formation temperature, and the steepness of this relation is found to increase with effective temperature. Furthermore, we are able to show that for most stars in our sample for which their rotational and magnetic cycles are well-sampled, both the short- and long-term activity signals are amplified when measured in the coolest and hottest formation temperature ranges. The ability to mitigate rotational and magnetic activity on the spectral level, by means of differentiating it from a pure Doppler signal which affects the entire spectrum equally, is a promising tool in the search for long-period Earth-like exoplanets.