GJ 526: A Search of Planets in Our Cosmic Backyard

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Summary

M-dwarfs are the most abundant stars in our galaxy, and their low masses create attractive opportunities for exoplanet detection. One such star, GJ 526, resides near the Sun and has a well-defined activity. We use HIRES, HARPS, CARMENES and high-precision ESPRESSO spectroscopy to: (1) study the stellar activity of GJ 526; (2) propose suitable indicators that describe activity-induced RV signals; (3) detrend the RV timeseries to seek for low-mass planets.

We utilise one- and multi-dimensional GPs to model the stellar activity of GJ 526. Through ESPRESSO RV&FWHM data, we constrain its rotational period to $48.8^{+0.2}_{-0.3}$ d, and observe long-lived activity regions. Analyses of other activity indicators reveal different results. We are currently combining all available velocimetry to provide with a complete, multifaceted analysis.

Who I am

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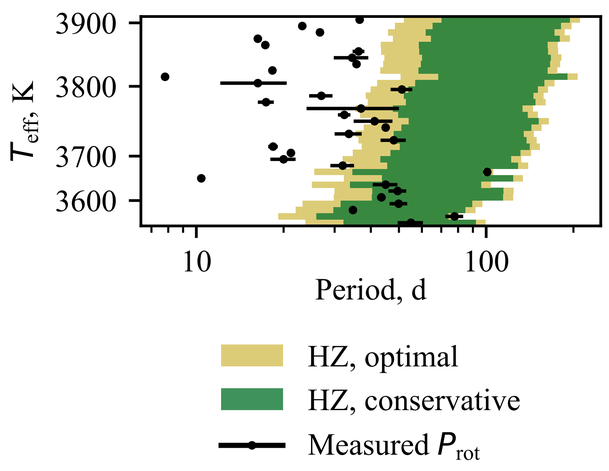
Context

M-dwarfs – the least massive and the most prevalent stars in the Galaxy – are the theoretical favourites for exoplanetary radial-velocity (RV) detection. In practice, however, these stars stubbornly mask potential planetary RV signals through physical processes such as: stellar oscillations, granulation, stellar activity on both short and long timescales. To make matters worse, M-dwarfs often exhibit strong activity at periods that overlap with the habitable zone of potential planetary companions. It is therefore important to understand better how stellar activity affects RV measurements, and then bring insights into the field to improve our ways of exoplanetary detection.

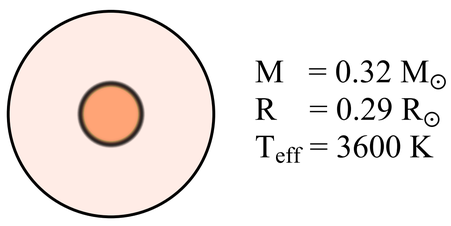
Rotation against HZ in HADES M-dwarfs



Target selection

We examine GJ 526 ($V = 8.5$ mag; $d = 5.4$ pc), a nearby M-dwarf that has been known to exhibit particularly weak stellar activity. GJ 526 has been studied by several RV programmes: HIRES, HARPS, CARMENES, ESPRESSO. Together, they provide with high-precision velocimetry that spans over 10^4 d. So far, there has been no evidence of planets around GJ 526. The detection of one would add to the statistics of the solar neighbourhood, which remains relatively unexplored.

Size of GJ 526 against the Sun

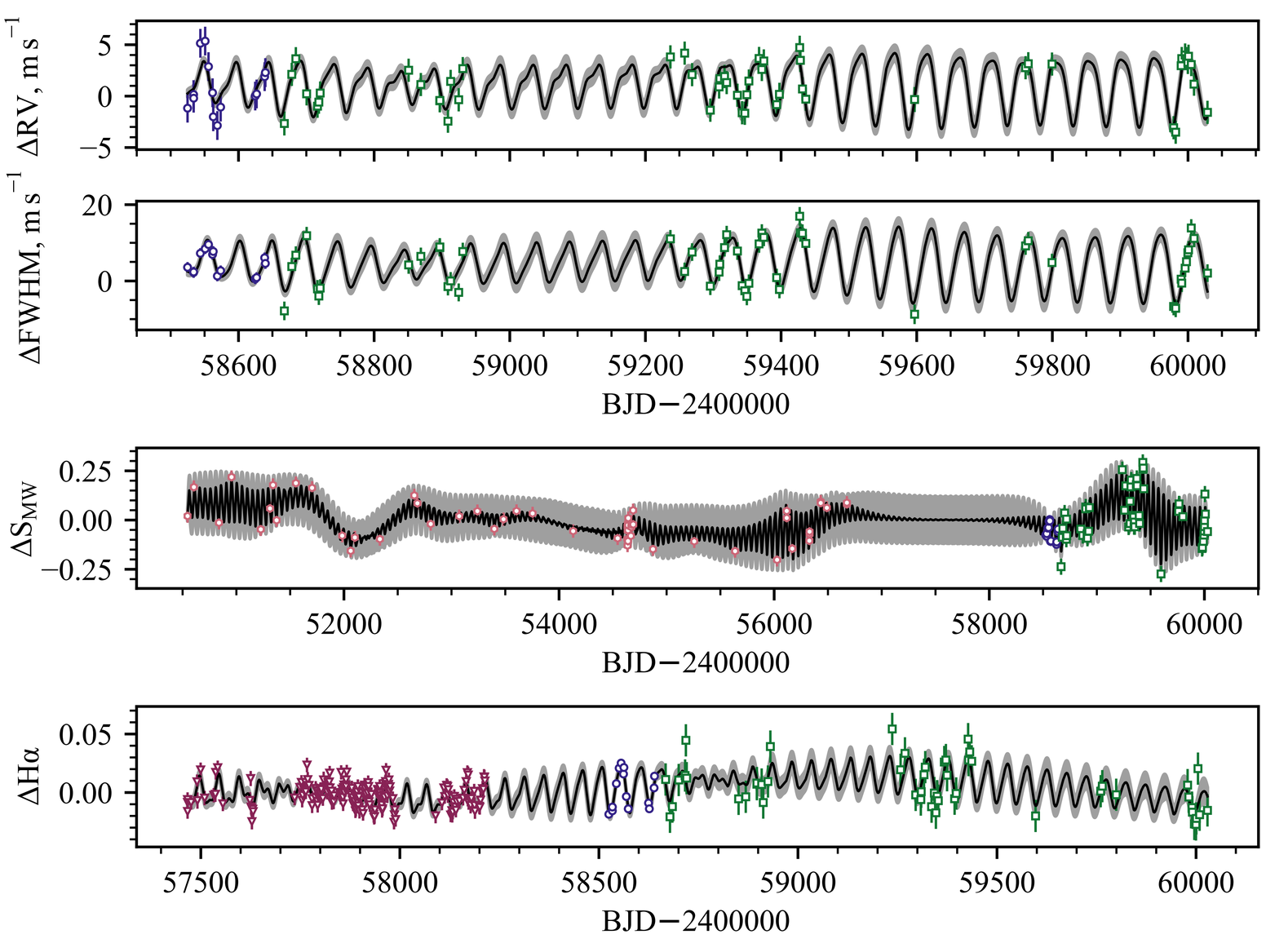


Current results and next steps

We use Gaussian processes (GPs) together with nested sampling to model GJ 526's stellar activity. We employ multi-dimensional GPs (Delisle et al., 2020; Rajpaul et al., 2015) on ESPRESSO RV&FWHM timeseries to constrain GJ 526's rotational period to $P_{\rm rot} = 48.8^{+0.2}_{-0.3}$ d and the timescale of its active regions to $\tau > 10^3$ d. However, our one-dimensional analyses of the S-index ($S_{\rm MW}$; ESPRESSO, HIRES) and Hα (ESPRESSO, CARMENES) reveal different $P_{\rm rot}$ and τ. Activity indicators and their time derivatives show complex relationships with RV measurements. RV appears to lag behind FWHM and $S_{\rm MW}$; but is nearly out of phase with Hα.

An incorporation of all available velocimetry is underway. This would enable us to carry out a complete, multifaceted analysis of GJ 526's stellar activity. In addition, we are exploring the possibility of extracting stellar-surface information from line-profile perturbations in the raw spectra, while the star is rotating.

Stellar-activity modelling



Dimension	$P_{\rm rot}$, d	τ, d
RV&FWHM	$48.8^{+0.2}_{-0.3}$	–
$S_{\rm MW}$	$48.4^{+0.5}_{-0.8}$	270^{+240}_{-150}
Hα	$49.5^{+0.2}_{-0.3}$	700^{+760}_{-310}

Stellar-activity phase differences