Exploring persistent Doppler signals in rapidly-rotating M dwarfs

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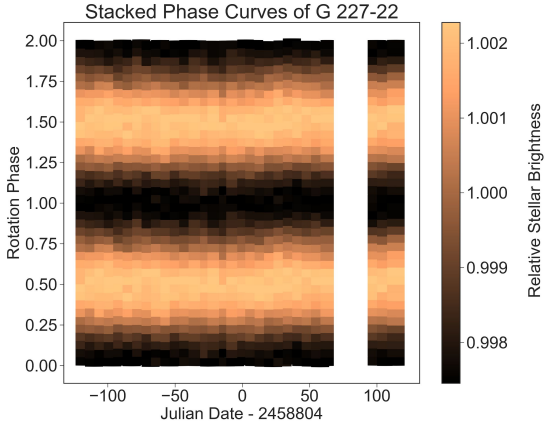
Planets or Starspots? Young, rapidly-rotating M dwarfs (e.g. AD Leo; Tuomi et al. 2018) have been identified as exoplanet candidate hosts due to persistent, periodic Doppler variability. However, starspot activity can contaminate radial velocity (RV) time series, introducing noise and creating false positives. We obtained multi-waveband (optical and NIR) RV spectroscopy of 4 rapidly-rotating, fully convective M dwarfs with the HIRES spectrometer on Keck and the Habitable-zone Planet Finder on HET. We analyzed these RVs alongside space-based photometry in order to determine the origin of persistent Doppler signals on these stars.

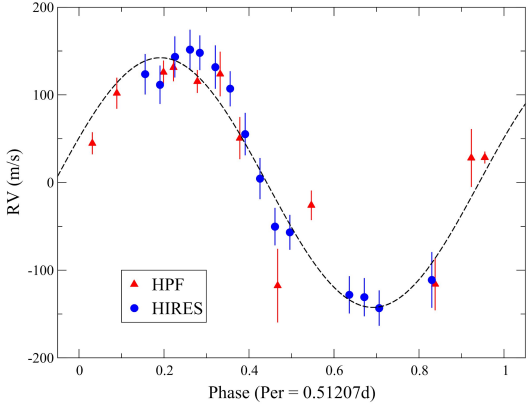
Target	T_{eff} (K)	Mass ($M_\odot$)	P_{rot} (d)	Inclination (°)
AD Leo	3382	0.43	2.24	17
G 227-22	3124	0.16	0.28	19
GJ 3959	3008	0.16	0.51	23
GJ 1245B	2859	0.11	0.71	51

Targets:
"AD Leo analogs." Rapidly-rotating M dwarfs, viewed close to pole-on.

Data:
Optical RVs from Keck/HIRES
Near-infrared RVs from HET/HPF
Photometry from *Kepler*, TESS, and LCO



Starspot persistence: Lightcurves show spots/spot complexes persist on our targets for *much* longer than on Sunlike stars--hundreds of rotations! Stellar rotation signals remain coherent over characteristic timescales of 0.5-1 year.



RV (a)chromaticity: NIR RVs typically show lower-amplitude rotation signals, but not reliably! For GJ 3959 (above), the optical and NIR RVs are indistinguishable.

Takeaways: Young, rapidly-rotating M dwarfs have **long-lived starspot signals** that create RV signals which are **not reliably chromatic**. Exoplanet detection for these objects will require observational and analysis techniques different from those typically used for Sunlike stars.

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