

The mean longitudinal magnetic field

to understand stellar activity

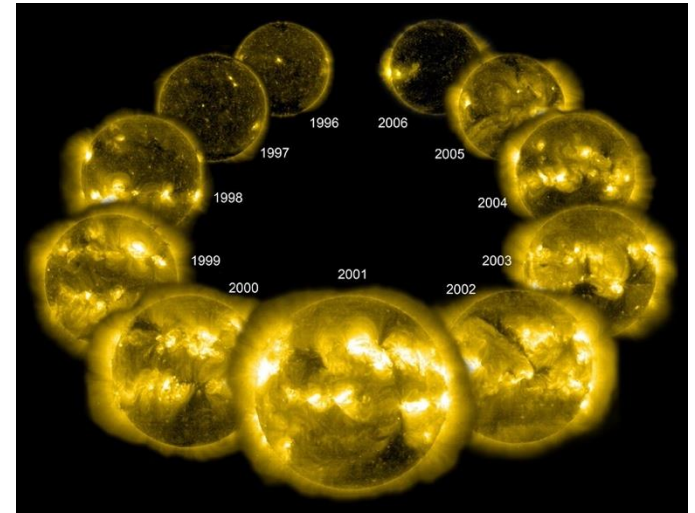
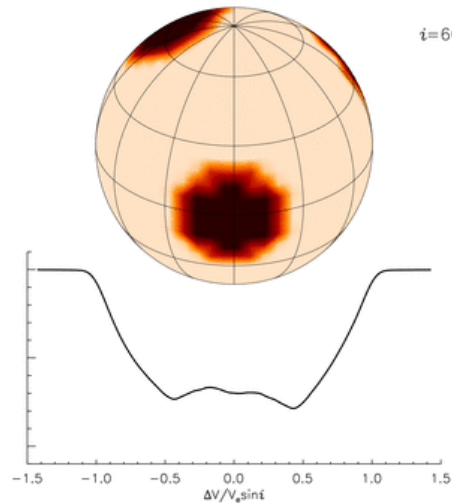
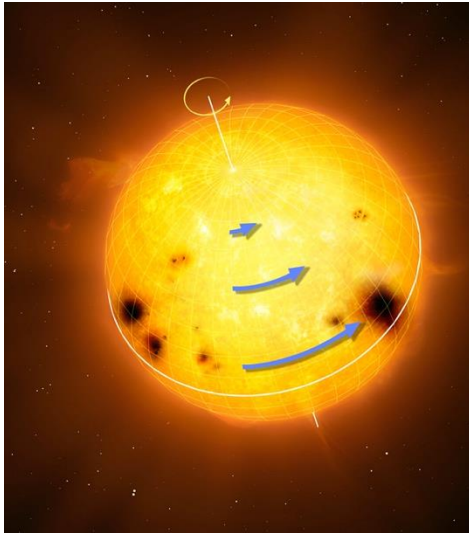
Dr. Federica Rescigno



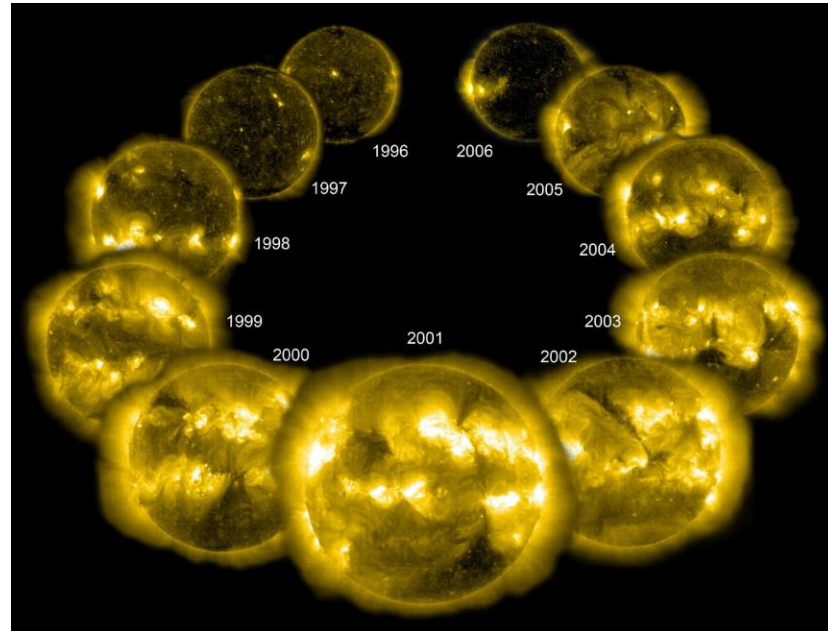
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BIRMINGHAM



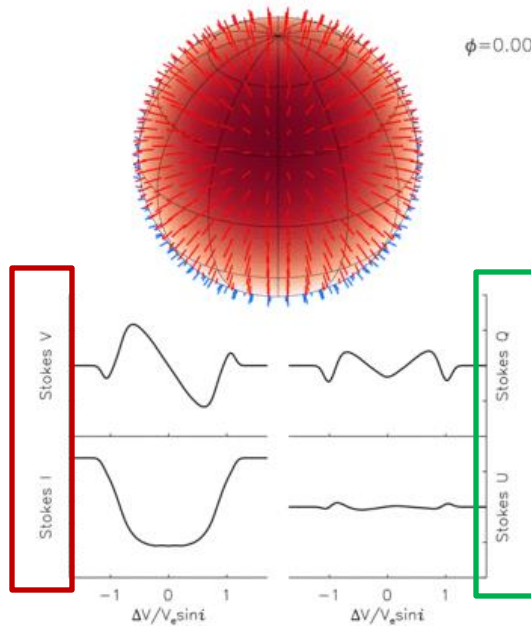
Proxies and Stellar Characteristics



Proxies and Stellar Characteristics



Magnetic Fields



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Unsigned Magnetic Flux as a Proxy for Radial-velocity Variations in Sun-like Stars

R. D. Haywood^{1,2}, T. W. Milbourne^{3,4}, S. H. Saar³, A. Mortier⁵, D. Phillips³, D. Charbonneau³, A. Collier Cameron⁶,
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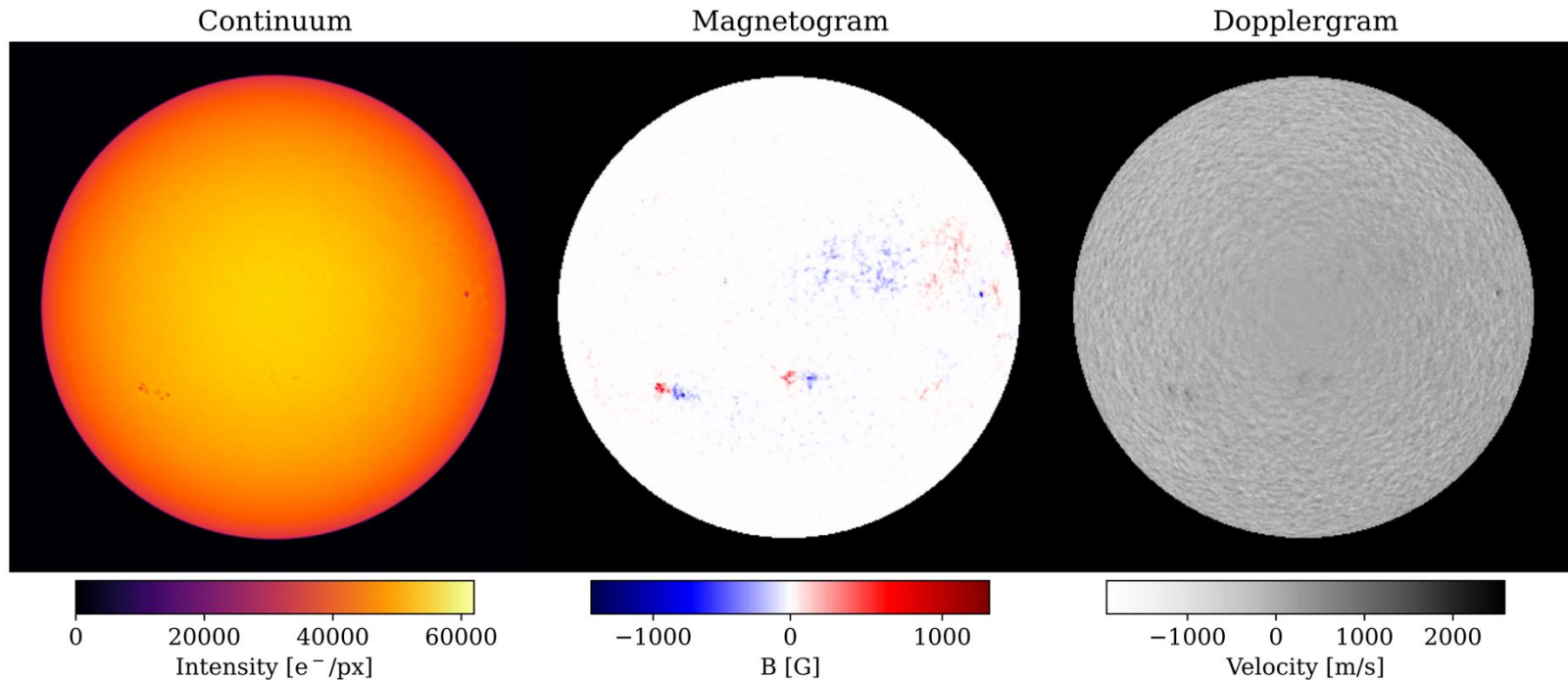
<https://doi.org/10.1093/mnras/stae1634>

The mean longitudinal magnetic field and its uses in radial-velocity surveys

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B. A. Nicholson⁵, M. López-Morales⁶, S. Dalal¹, M. Cretignier⁷, B. Klein⁷,
A. Collier Cameron^{8,9}, A. Ghedina¹⁰, M. Gonzalez¹⁰, R. Cosentino¹⁰, A. Sozzetti¹¹ and S. H. Saar⁶

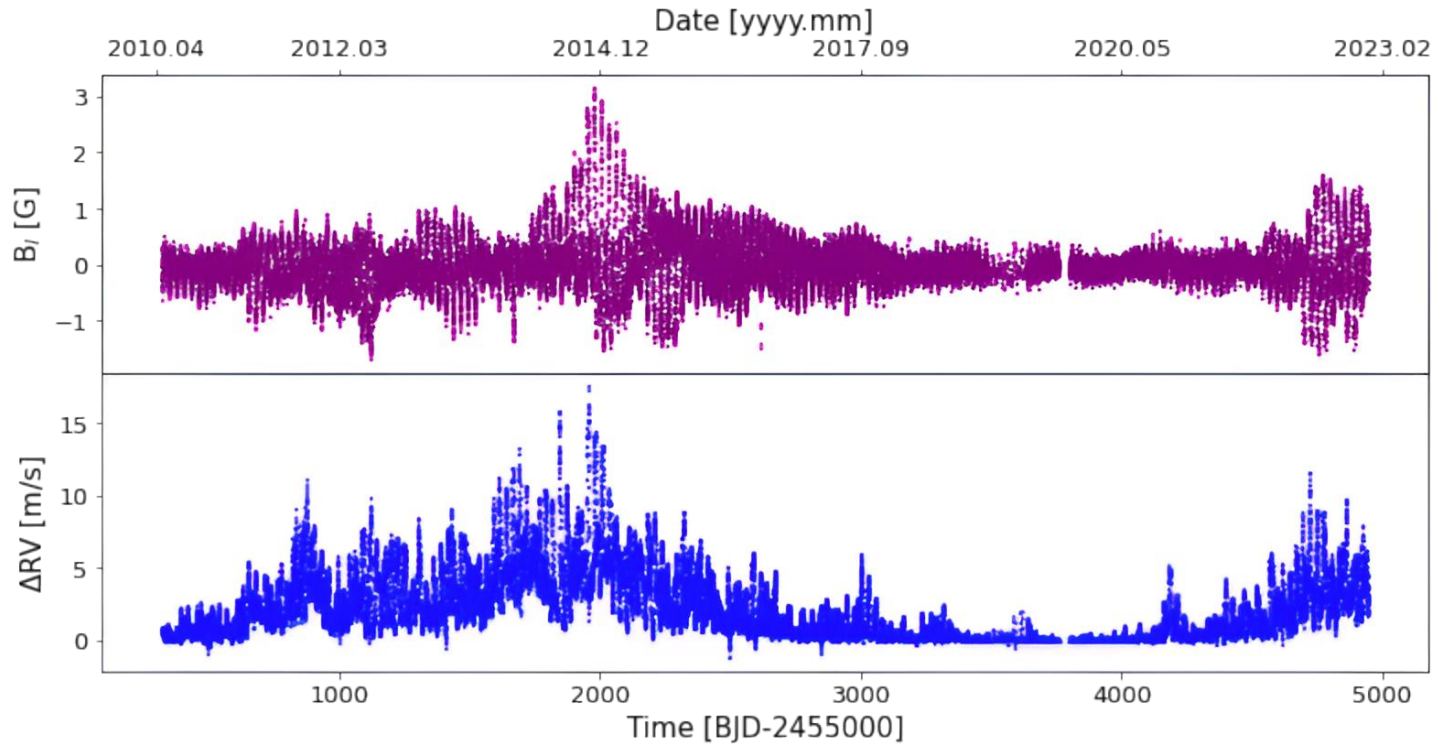
SDO/HMI filtergrams

Rescigno et al. 2024

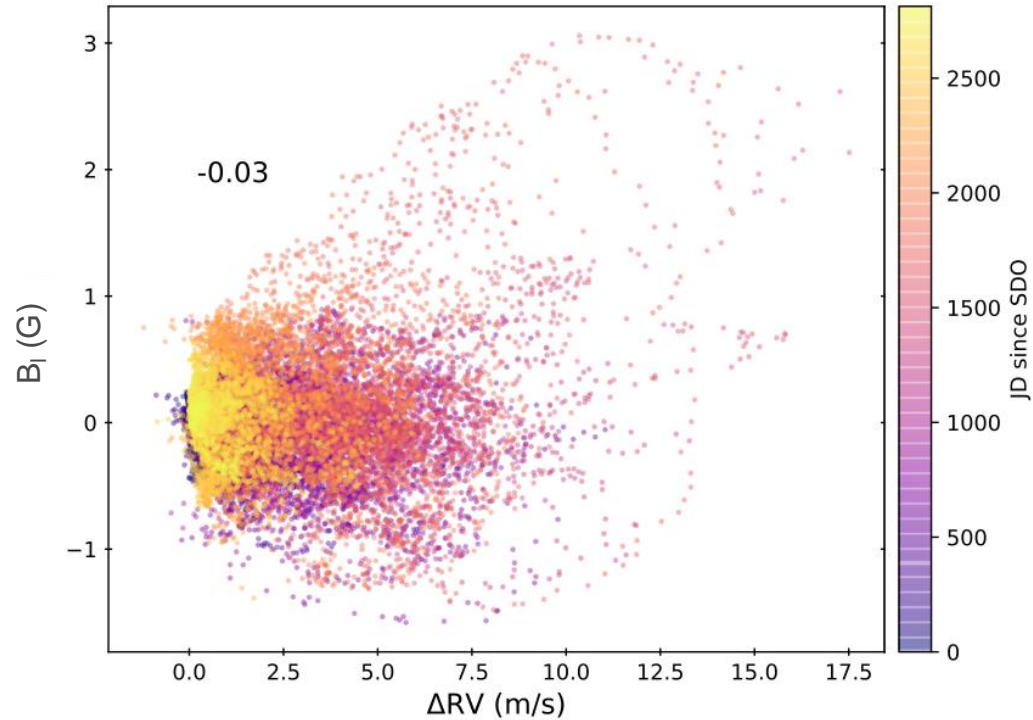


SDO/HMI Data - SolAster

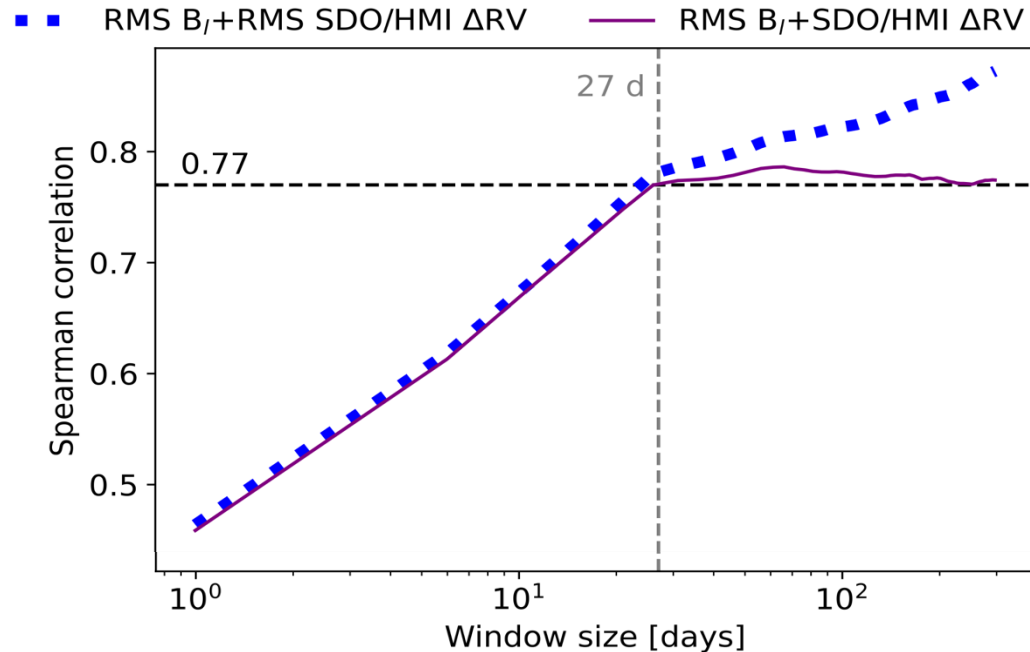
Haywood et al. 2016
Milbourne et al. 2019
Ervin et al. 2022



Correlation analysis: SDO RVs and B_l

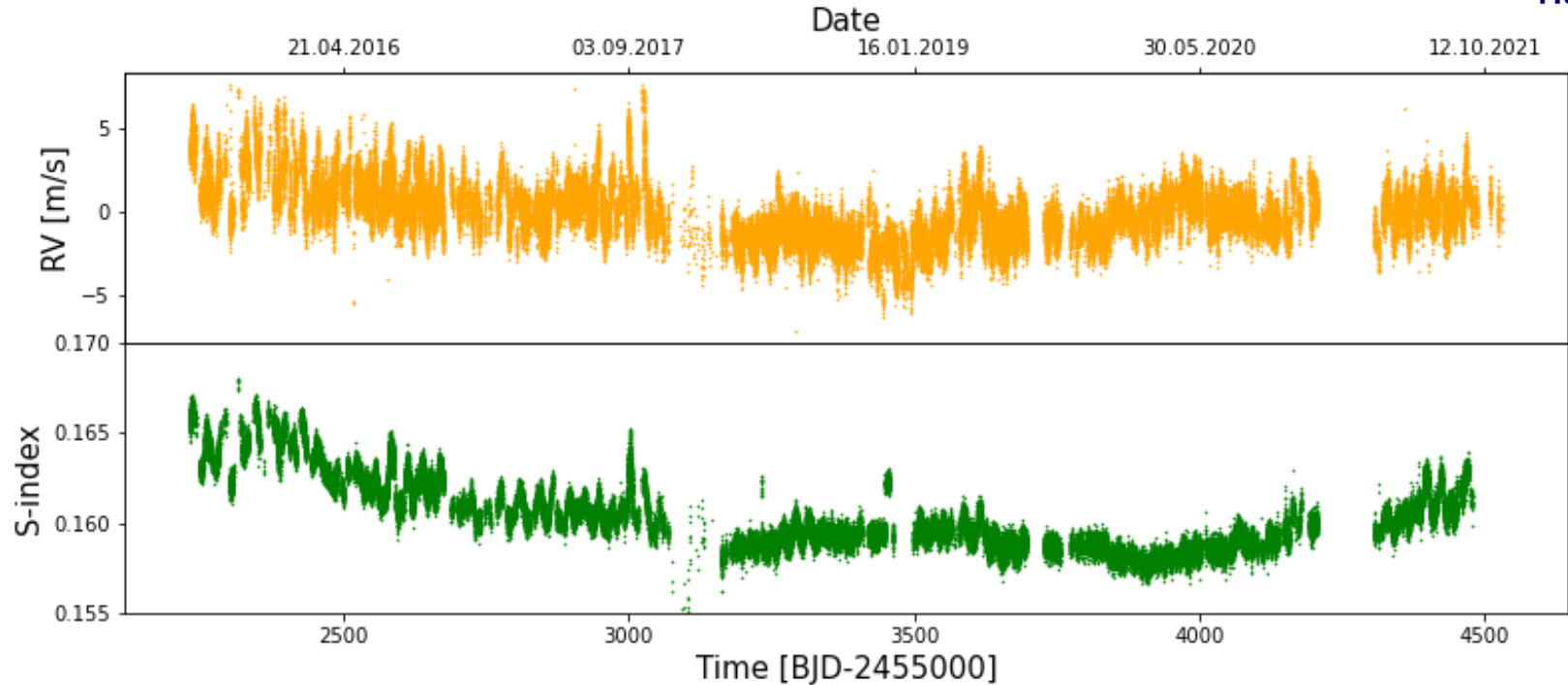


Correlations: RVs and B_l RMS

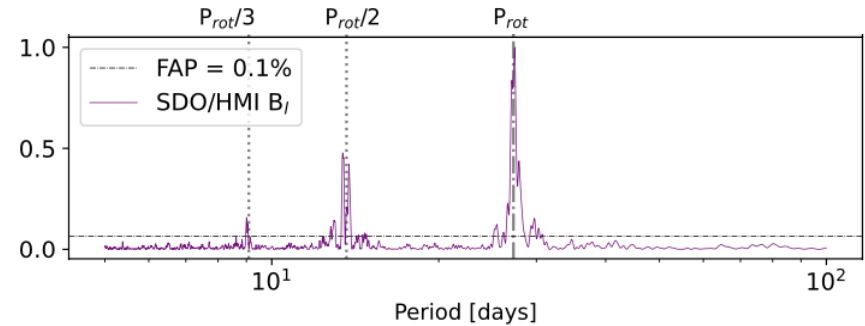
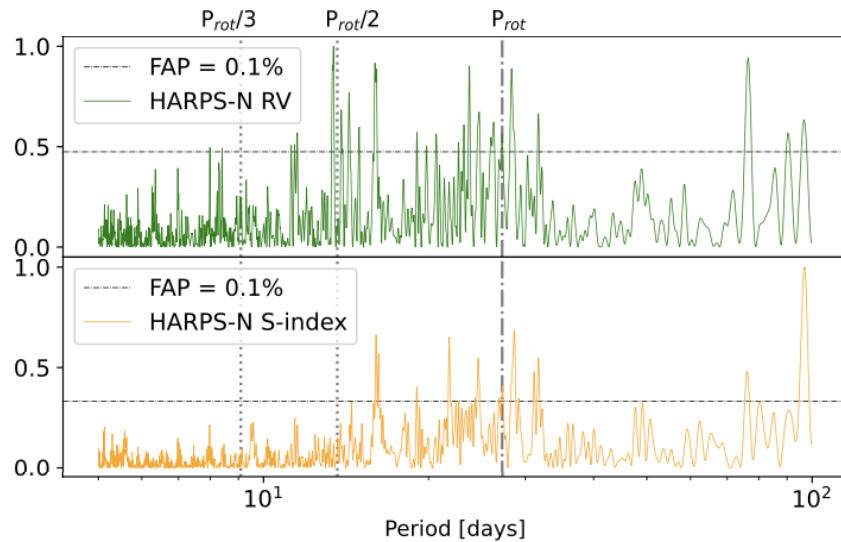




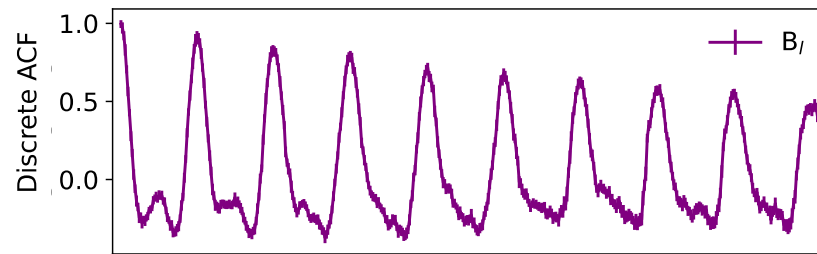
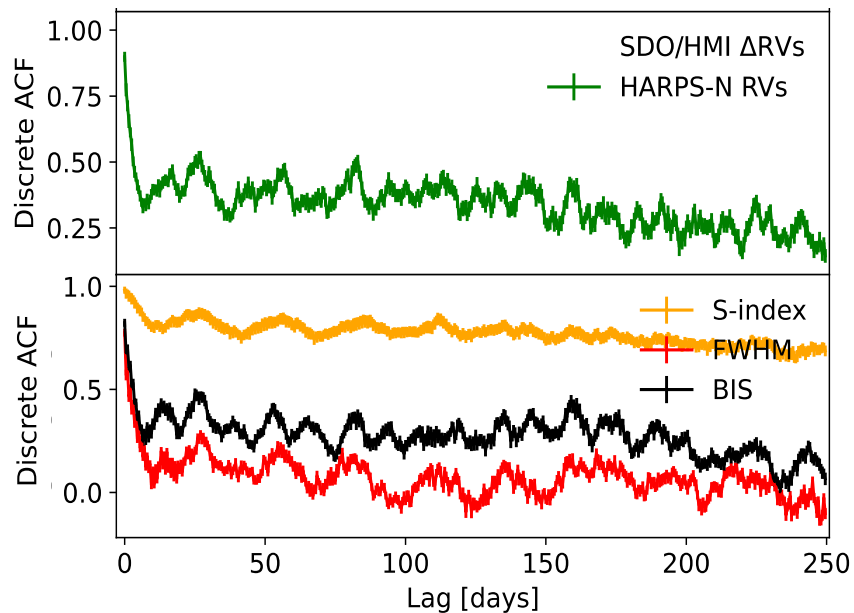
HARPS-N Solar Data



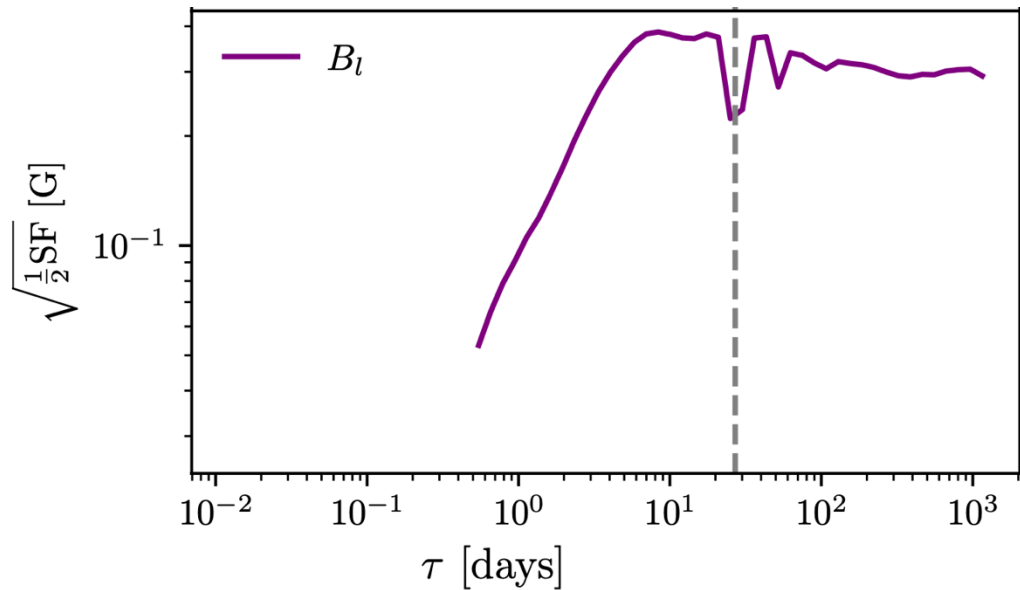
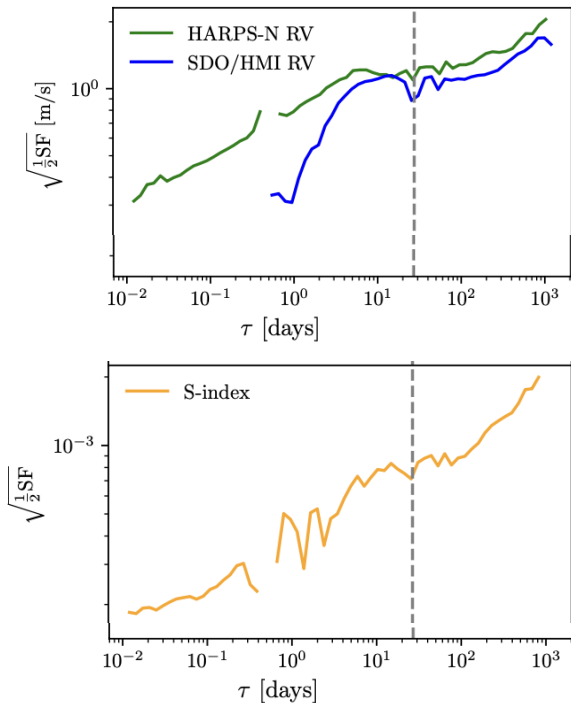
Periodograms

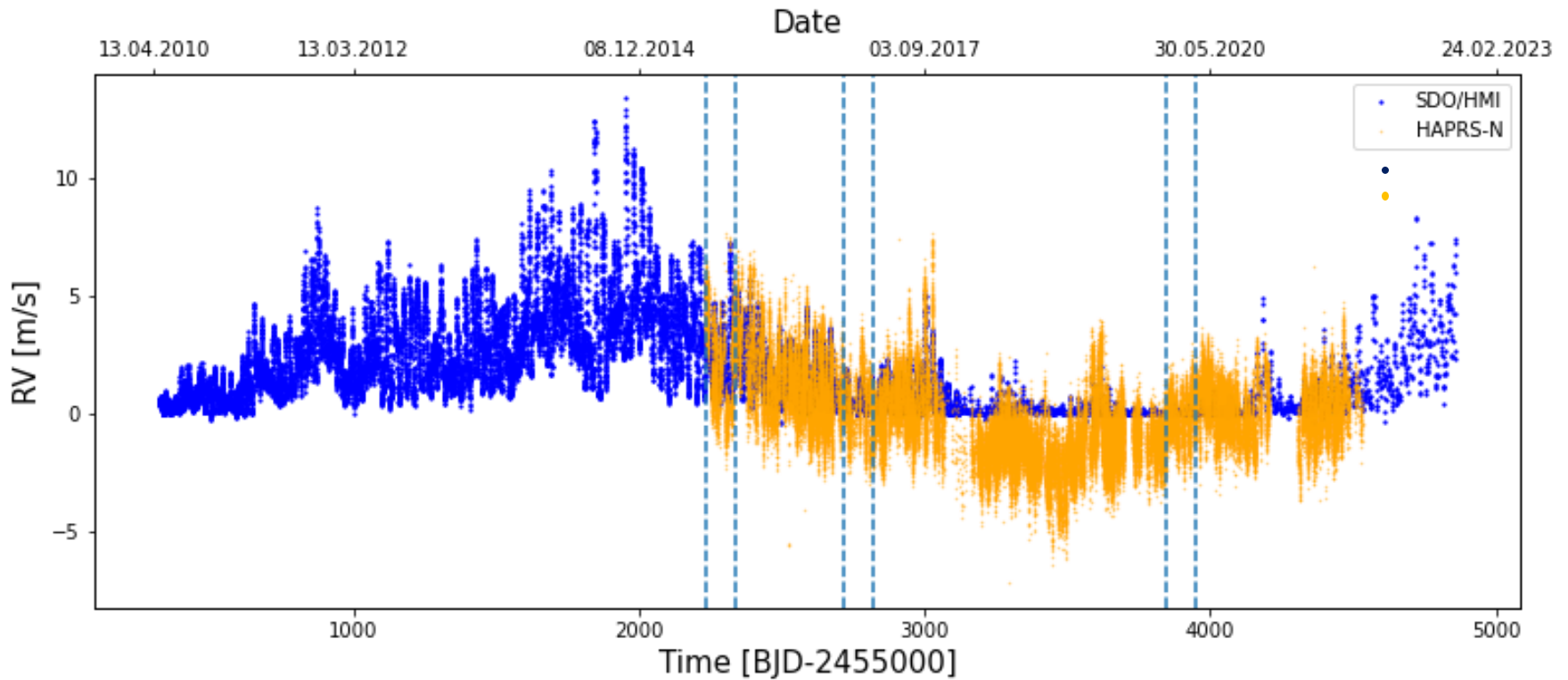


Autocorrelation



Structure functions



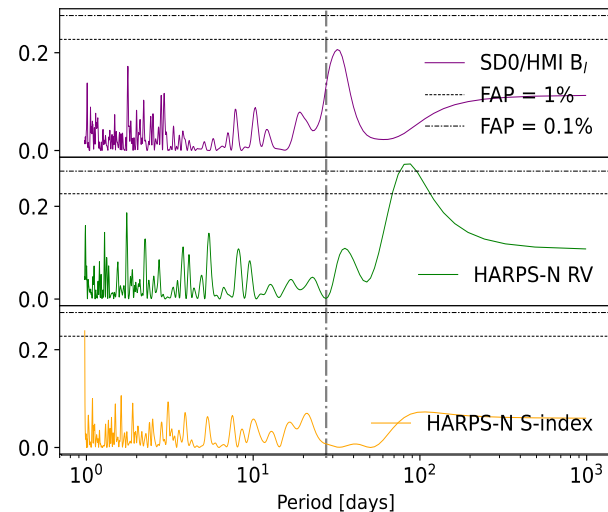
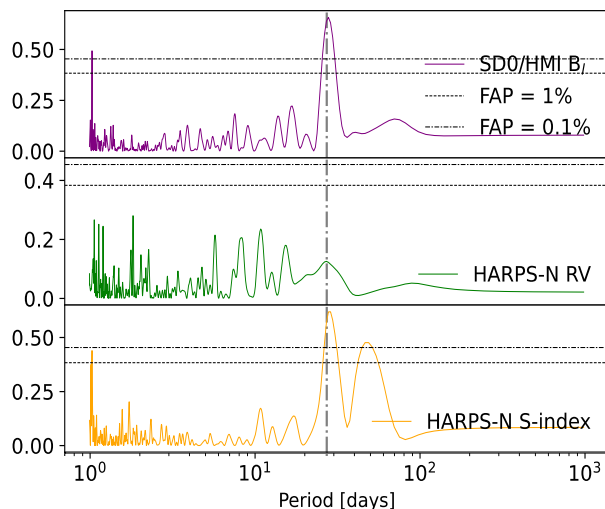
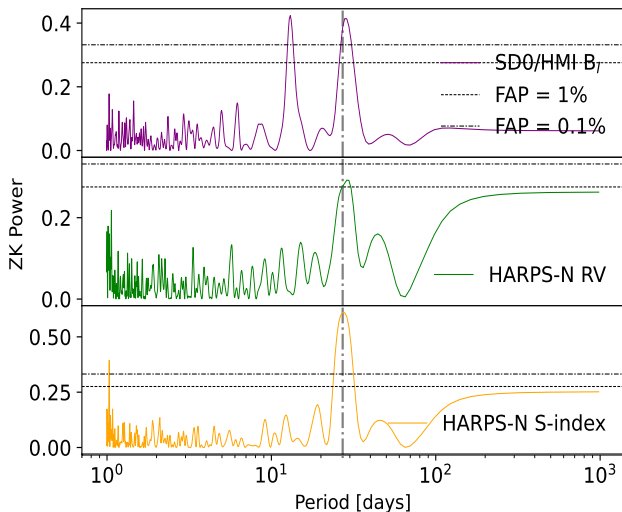


Basic periodograms at activity levels:

High

Medium

Low



Gaussian Process Regression



- Modelled using **MAGPy-RV** (Rescigno et al. 2024 a,b)
- Quasiperiodic Kernel with white noise “jitter” term

$$k(t_n, t_m) = \underbrace{\theta_1^2}_{\text{Amplitude}} \cdot \exp \left[- \frac{|t_n - t_m|^2}{\underbrace{\theta_2^2}_{\text{Evolution timescale}}} - \frac{\sin^2 \left(\frac{\pi \cdot |t_n - t_m|}{\underbrace{\theta_3}_{\text{Period}}} \right)}{\underbrace{\theta_4^2}_{\text{Harmonic complexity}}} \right] + \delta_{n,m} \underbrace{\sigma^2}_{\text{Jitter}}$$

Gaussian Process Regression



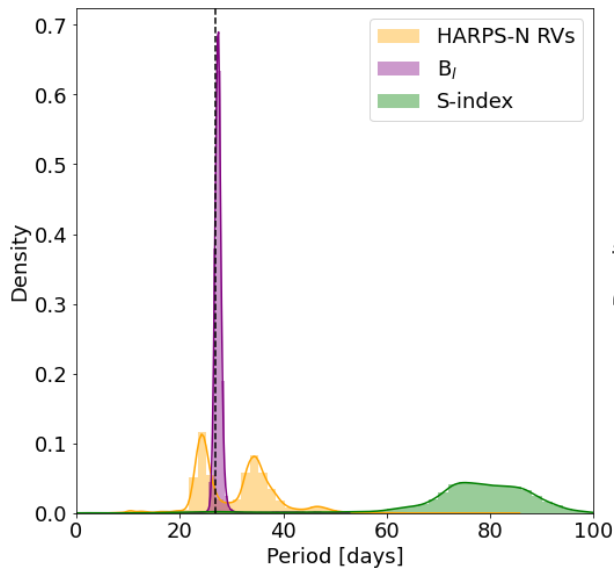
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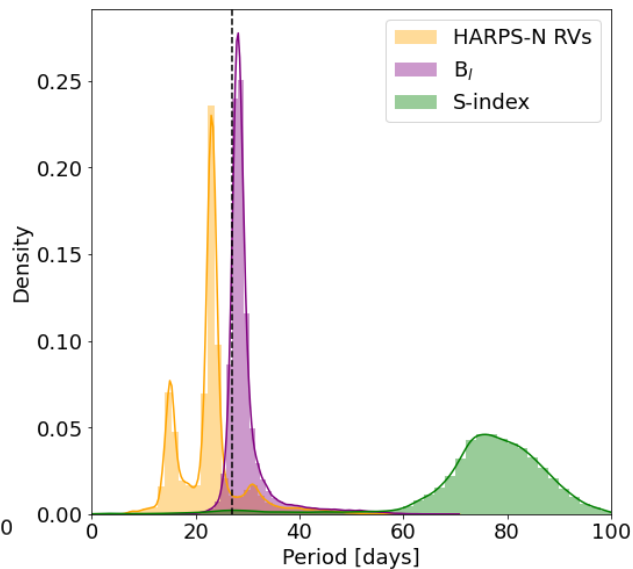


Period Posteriors

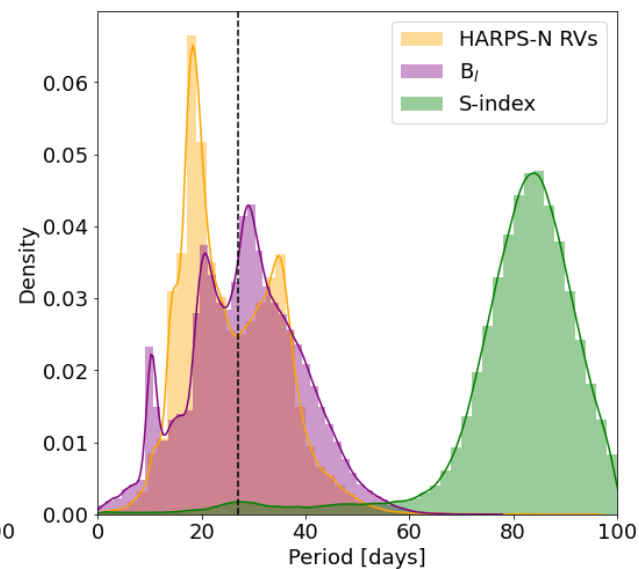
High



Medium



Low



Summary

- B_l does not correlate directly with RVs but its scatter can be used to model long-term effects due to the solar cycle
- B_l is an effective solar rotation detector and has a simpler signal structure than RVs and proxies.
- B_l outperforms the other activity indicators in preliminary periodogram and GP analyses.

Contact me



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Check out Bham Posters!

- #2.02 BiSON recalibration: 40 years of Sun-as-a-star data
- #2.03 RV variability of the magnetically quiet Sun
- #3.02 ABORAS: a polarizing solar telescope for HARPS3