HARPS-N radial velocities from the Sun-as-a-star

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Instruments can do it.
Let’s find all those Earths!
To ever really find and characterise an Earth twin, we will need to understand stellar variability.
The solar telescope feeding into HARPS-N

Courtesy: A. Glenday
The solar telescope feeding into HARPS-N

Operational since July 2015.
Daily 5-minute exposures from 9am till ~4pm.

Courtesy: A. Glenday
Jupiter clearly detected
Jupiter clearly detected - corrected using JPL Horizons
Daily downwards trend
Daily downwards trend - due to differential extinction?
Correct for differential extinction - rms still 1.6 m/s!!

(Collier Cameron, Mortier et al. 2019, submitted to MNRAS)
Stellar activity - a little perspective
Stellar activity - a little perspective

![Graph showing RV (m/s) over Julian date (JDB - 2450000)]
Solar RVs for $\sim$ 3 years - binned per day

(BGLS periodogram - Mortier et al. 2015)
Solar rotation at $\sim 28$ days and its harmonic at $\sim 13$ days clearly visible and unstable over time.

(Stacking periodograms - Mortier et al. 2017)
Data split in semesters

Strongest periodicity and its strength highly variable.
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Strongest periodicity and its strength highly variable.
What about our 'activity indicators'?
Similar periodicity behaviour - no correlation?
Temporal offset between RV, FWHM, BIS weakens their correlation. The delay is caused by the faculae suppressing the convective blueshift, combined with the fit of a Gaussian to the asymmetric CCF.
To know the planet is to know its star

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Studying the Sun-as-a-star helps us understand 'the noise', will allow us to test models and algorithms, is the way forward to detecting a true Earth twin.