Stellar Activity Indicators with Solar Observations

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JURA III
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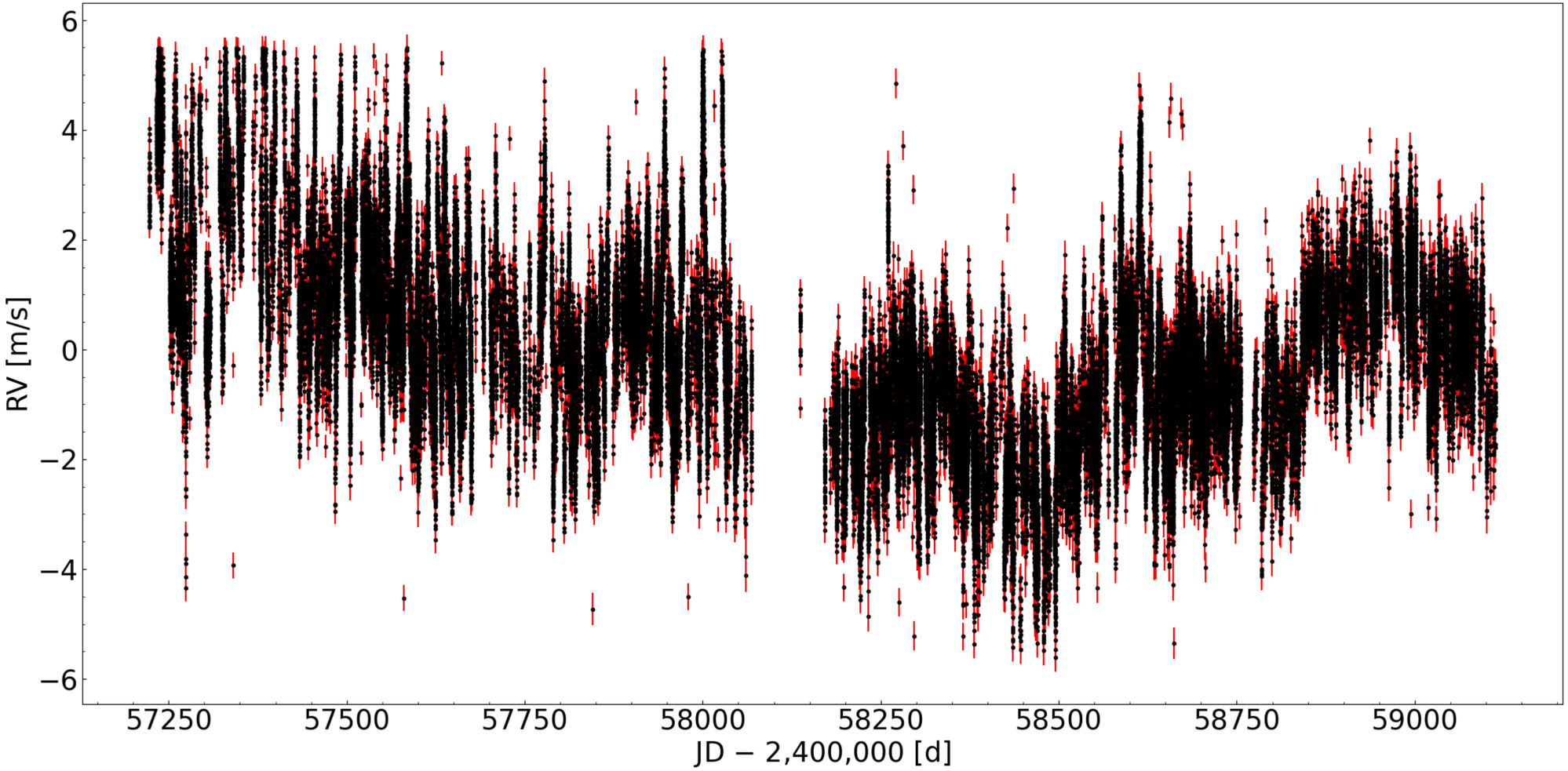
PlanetS

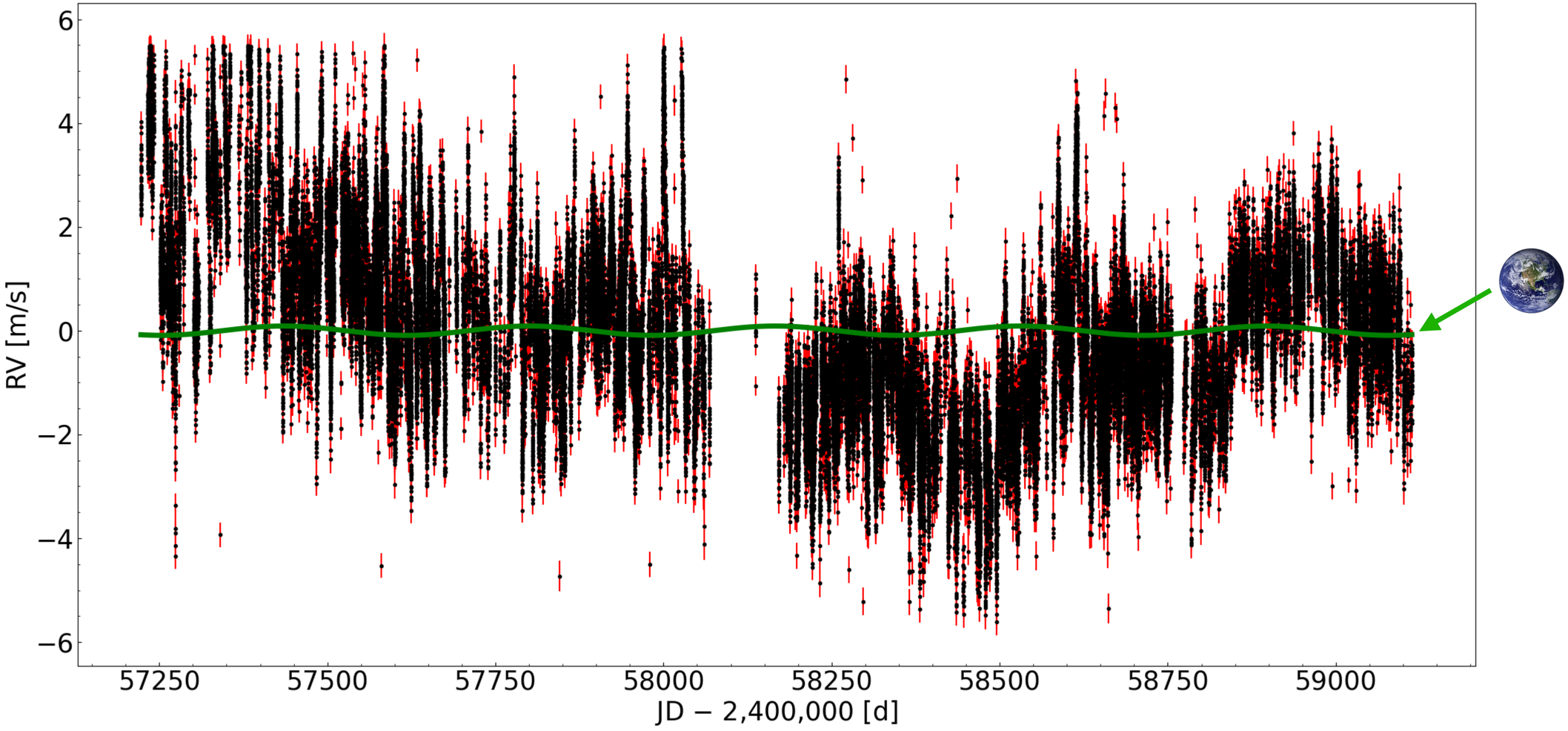
Image credit: Antonio Tartarini, APOD

Solar RVs with the HARPS-N spectrograph

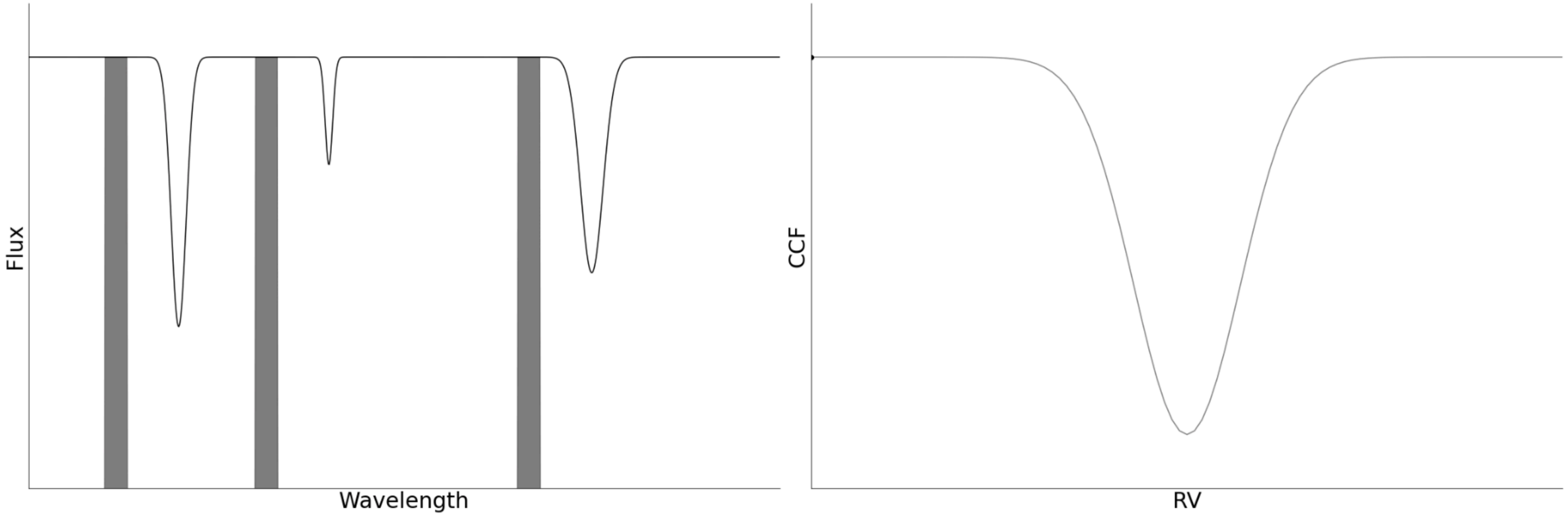


Credit: Alex Glenday

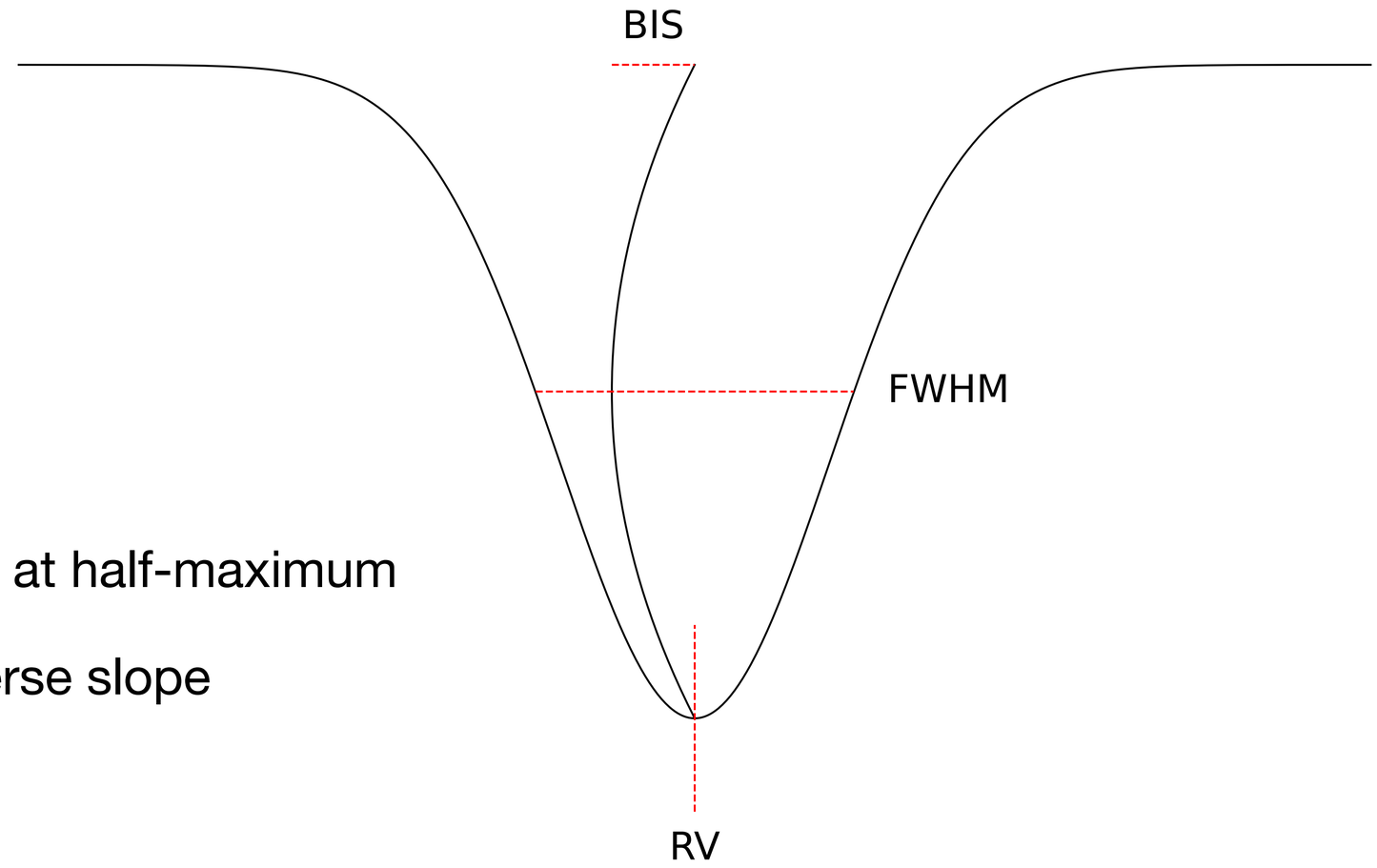
Solar RVs with the HARPS-N spectrograph



The cross-correlation function (CCF)



CCF moments : Definitions

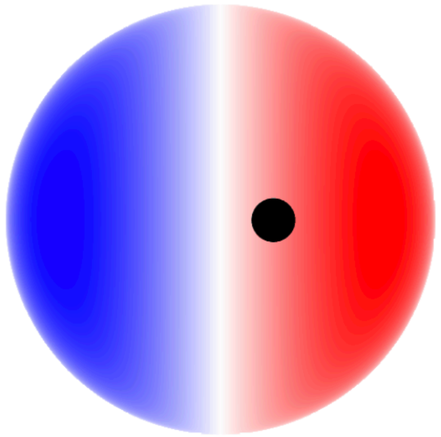


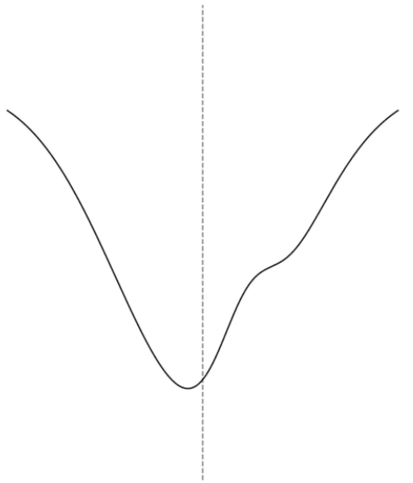
FWHM: full-width at half-maximum

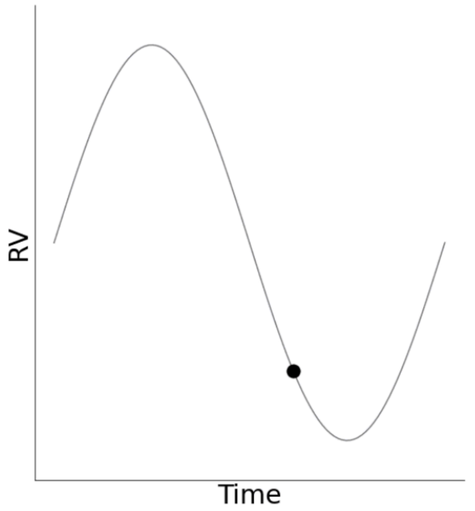
BIS: bisector inverse slope

RV effects of activity

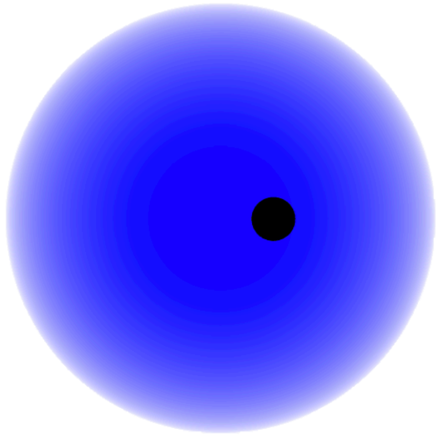
Flux imbalance

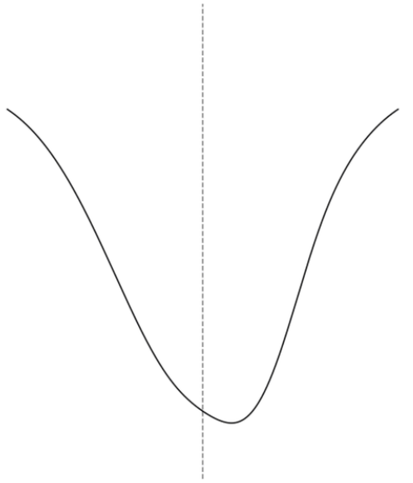


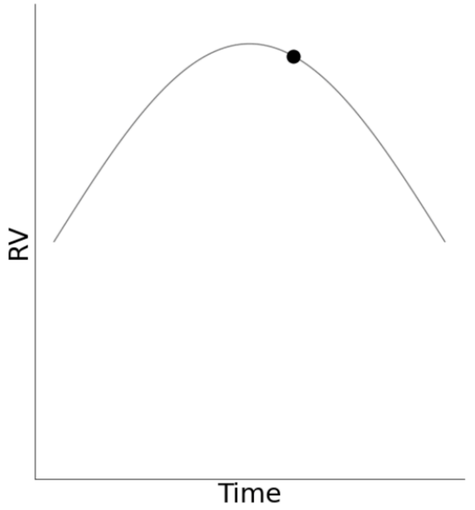




Convective suppression





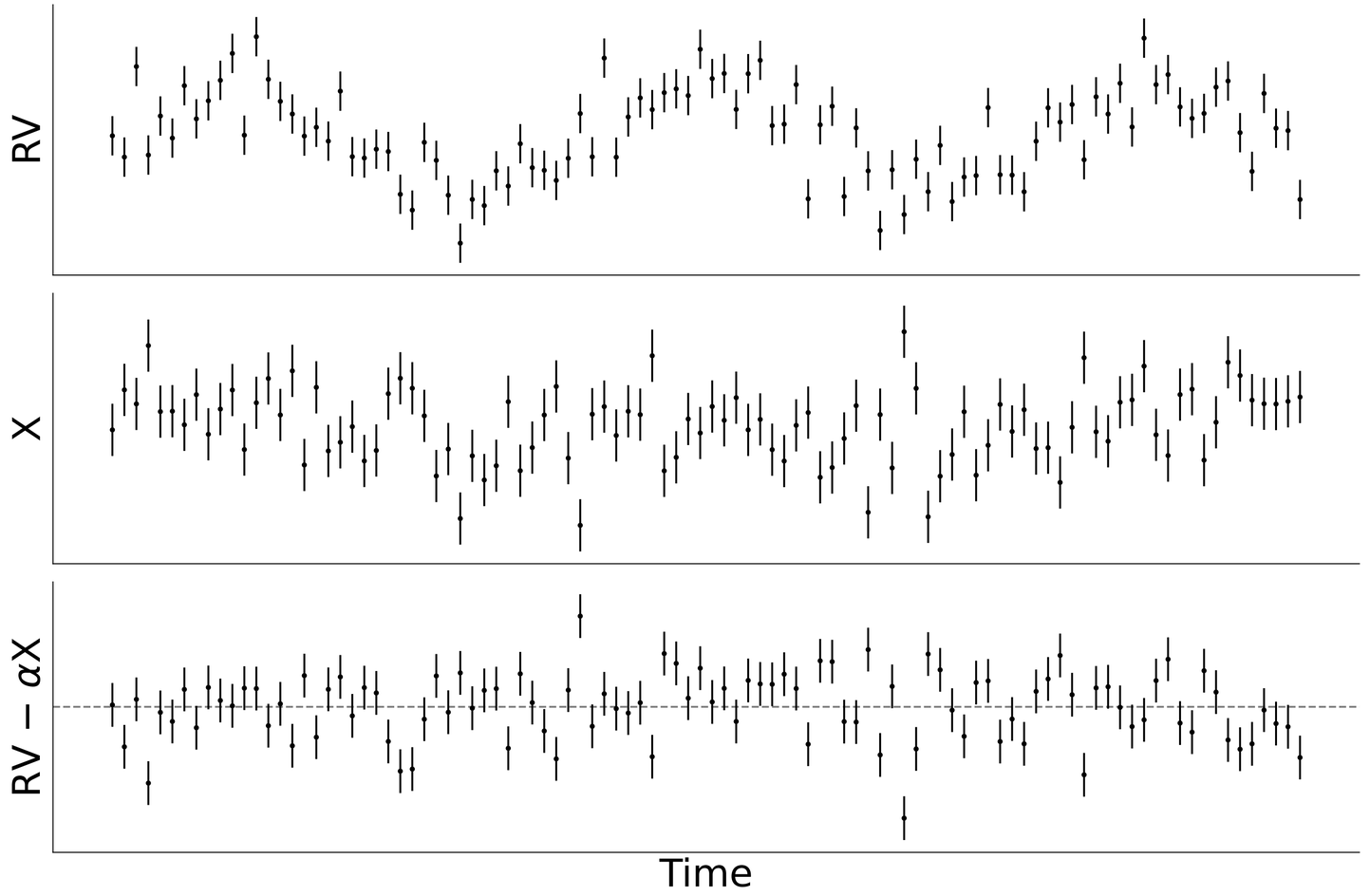


CCF moments : Activity indicators

$$\mathrm{RV} = \mathrm{RV}_{\mathrm{planet}} + \mathrm{RV}_{\mathrm{activity}}$$

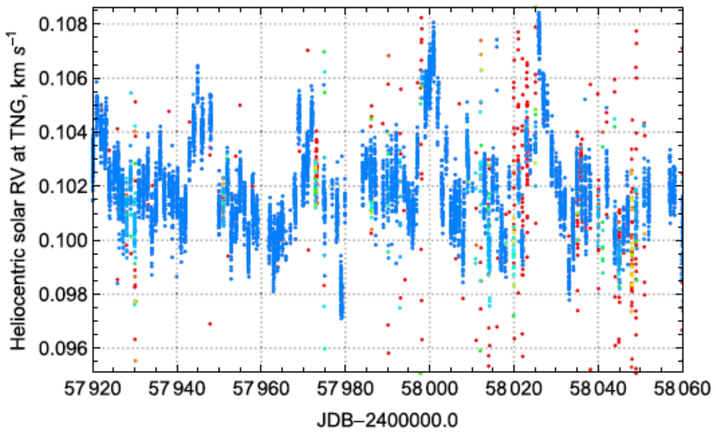
$$\mathrm{RV}_{\mathrm{activity}} \approx \alpha X$$

where X is the CCF FWHM or BIS

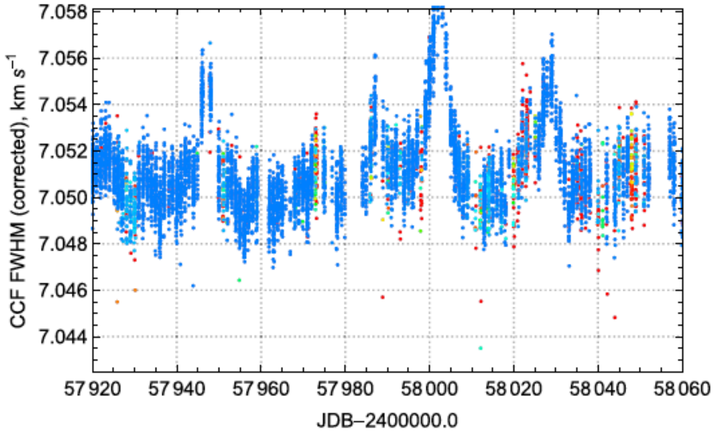


CCF moments : Activity indicators

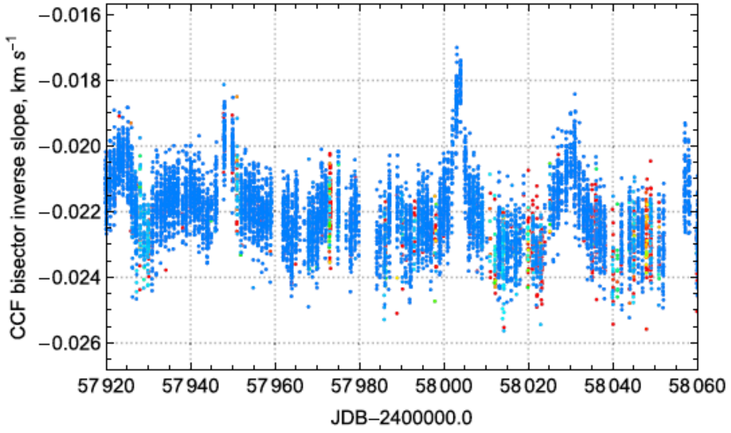
RV



FWHM



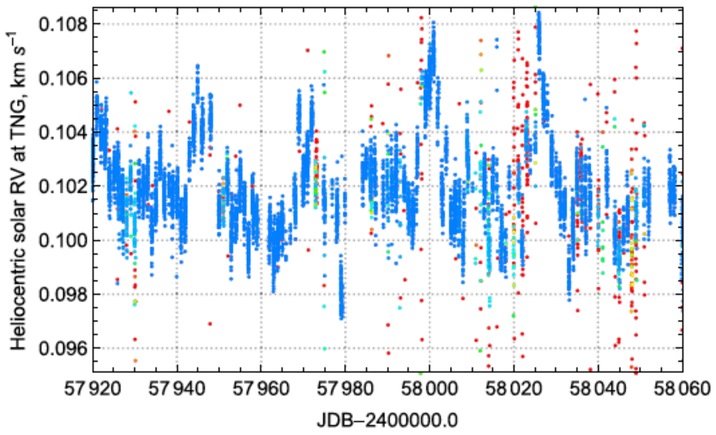
BIS



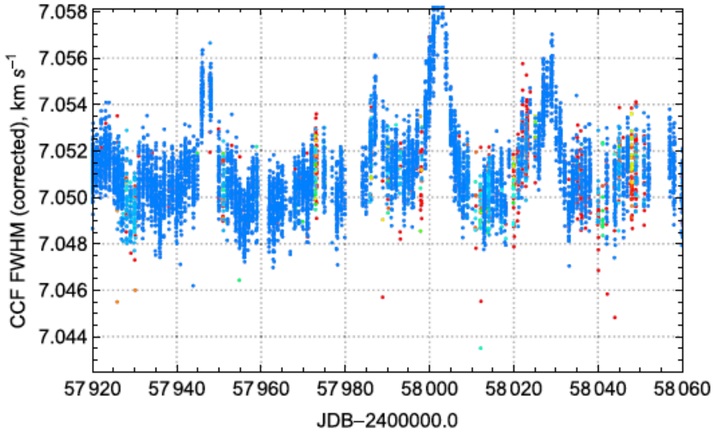
[Collier Cameron et al. 2019]

CCF moments : Activity indicators

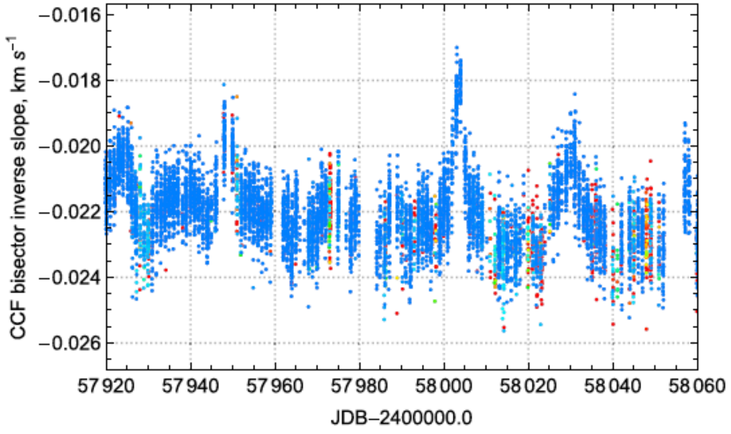
RV

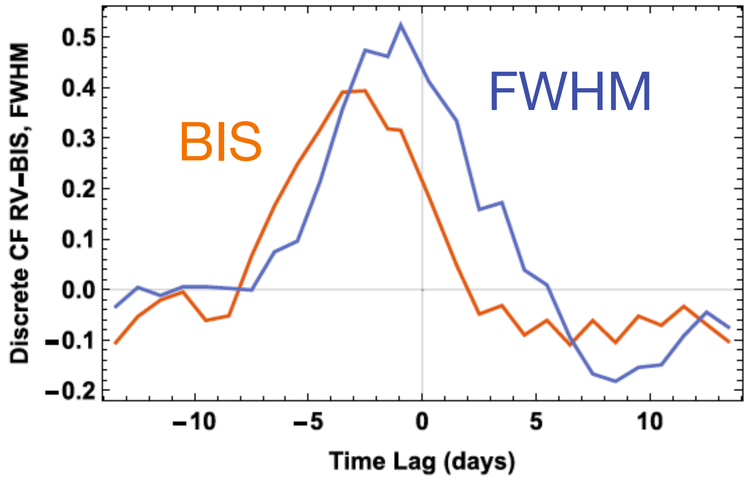


FWHM



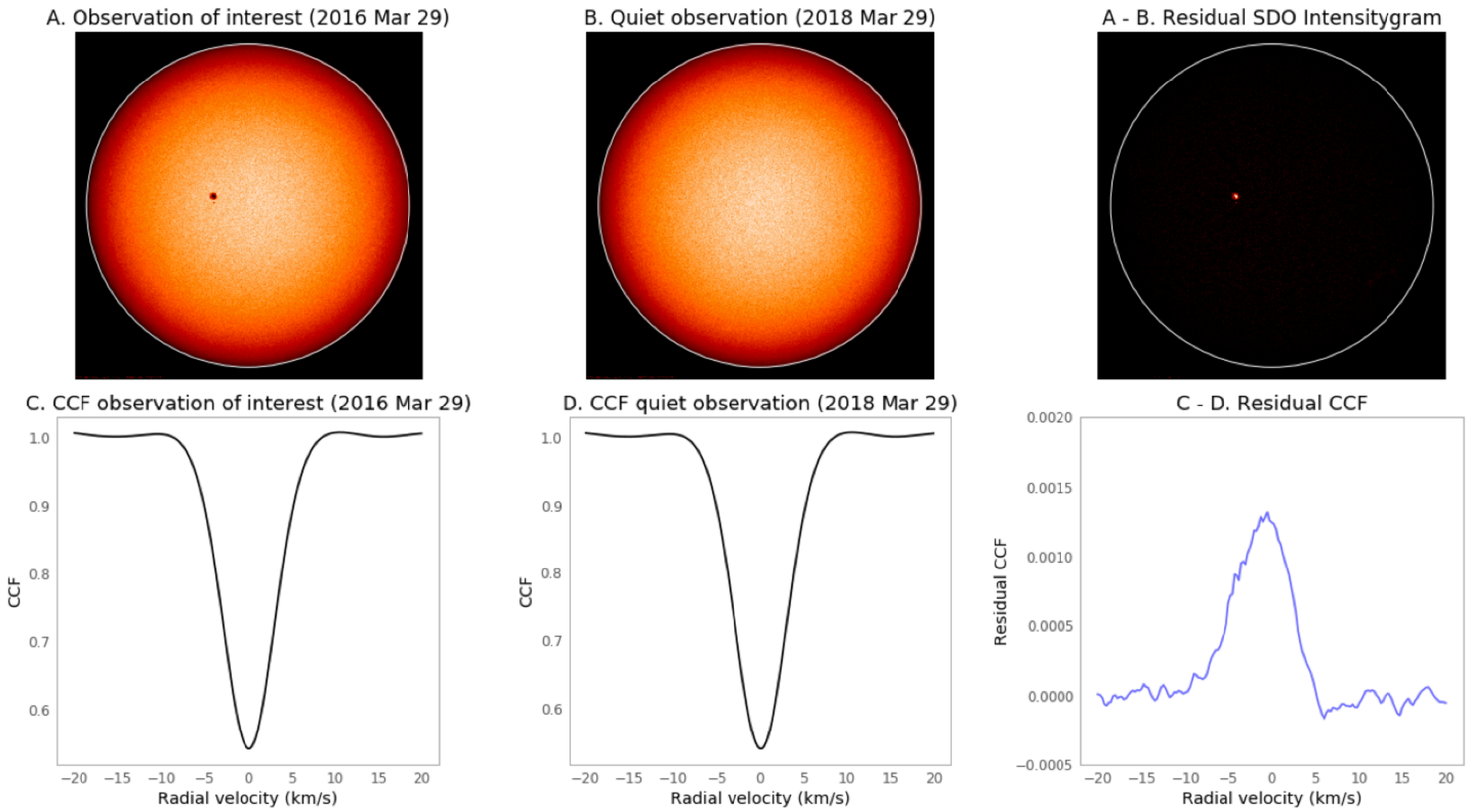
BIS

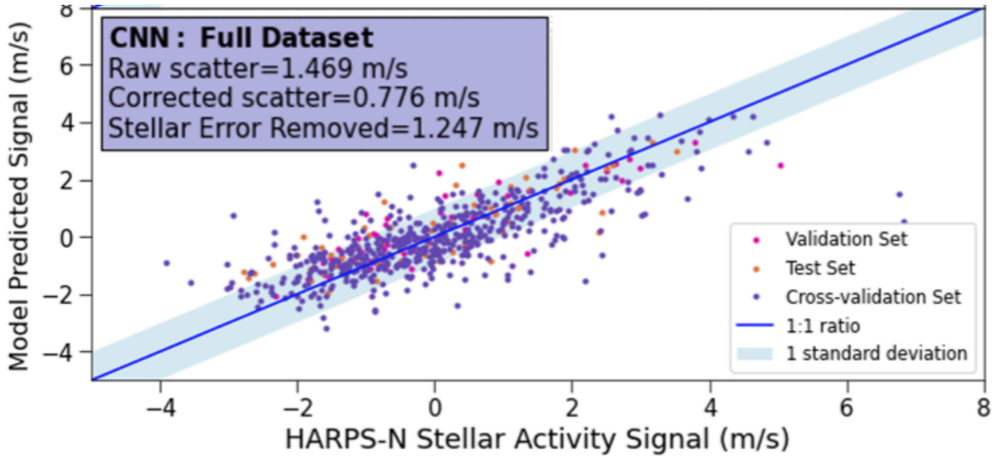




[Collier Cameron et al. 2019]

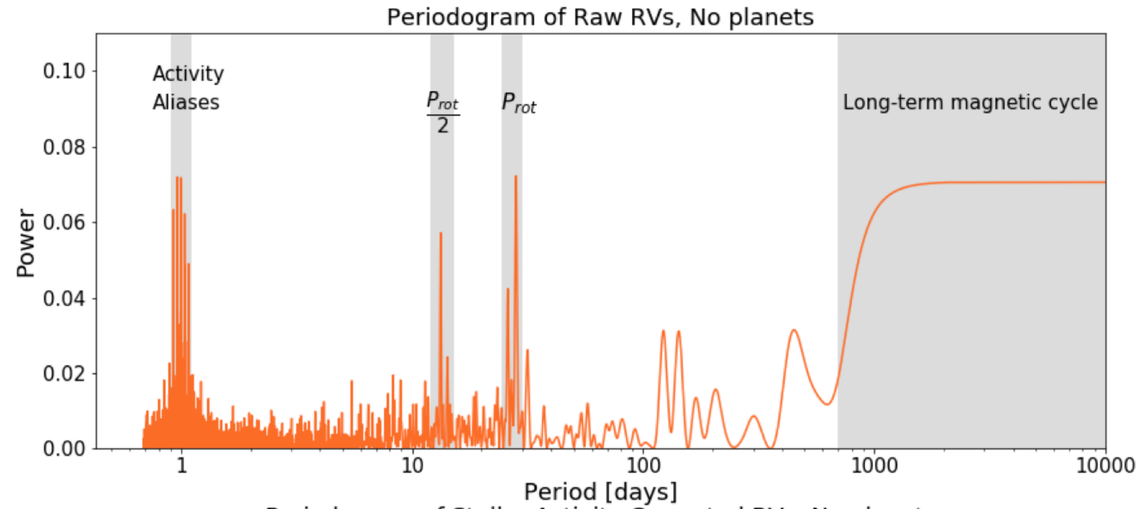
CCF residuals (with machine learning)

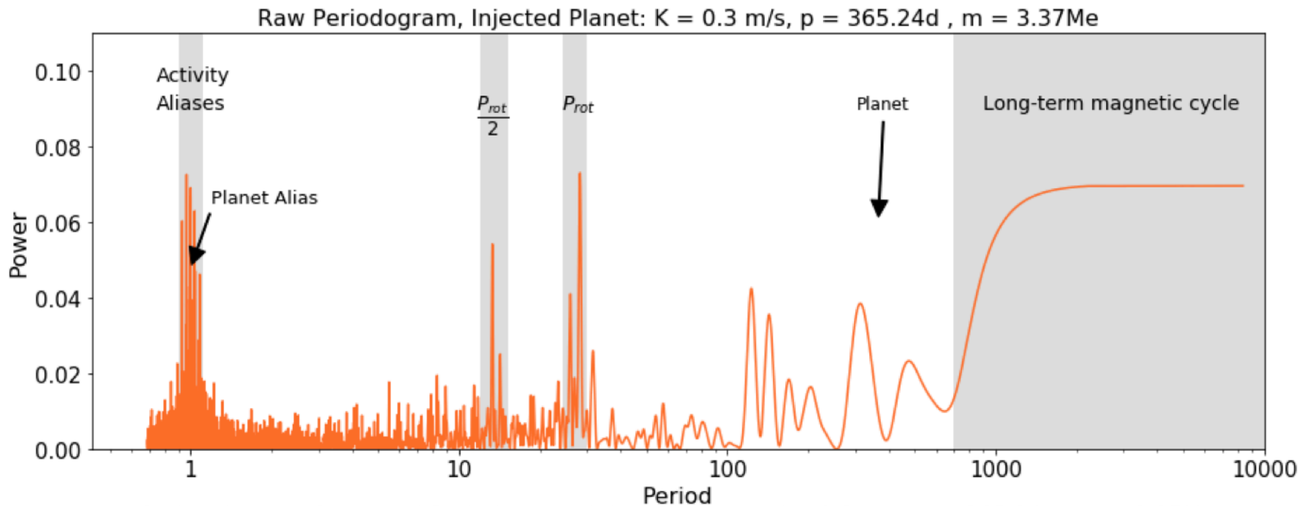


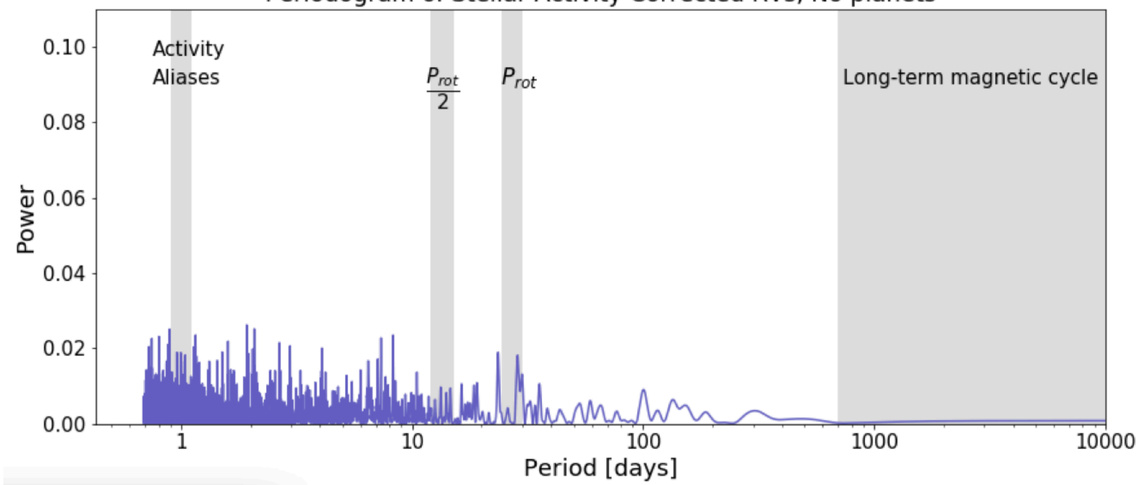


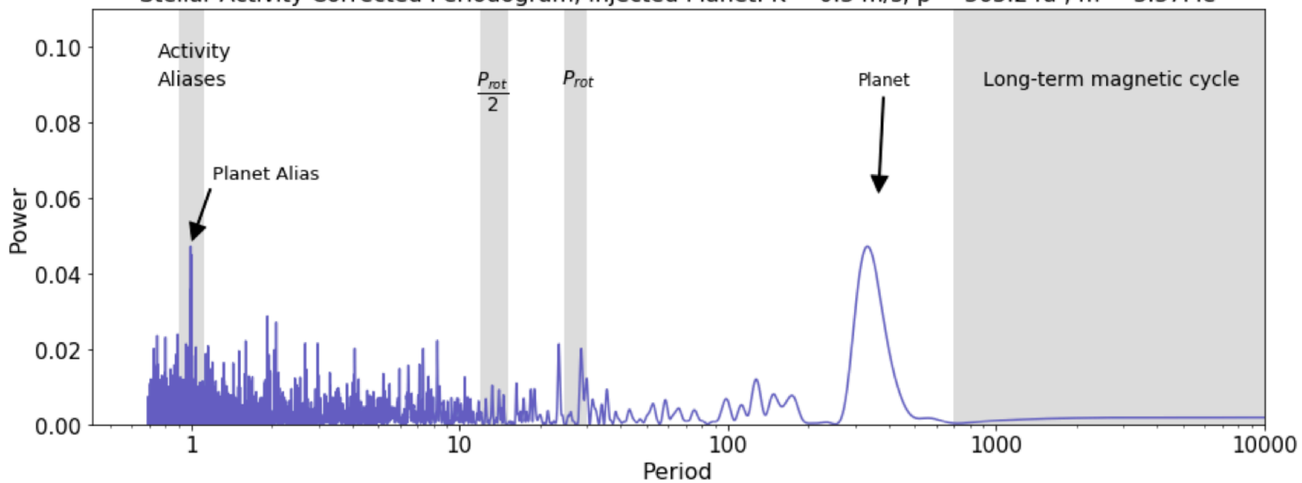
[de Beurs et al. 2020]

CCF residuals (with machine learning)



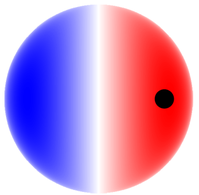


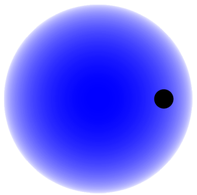


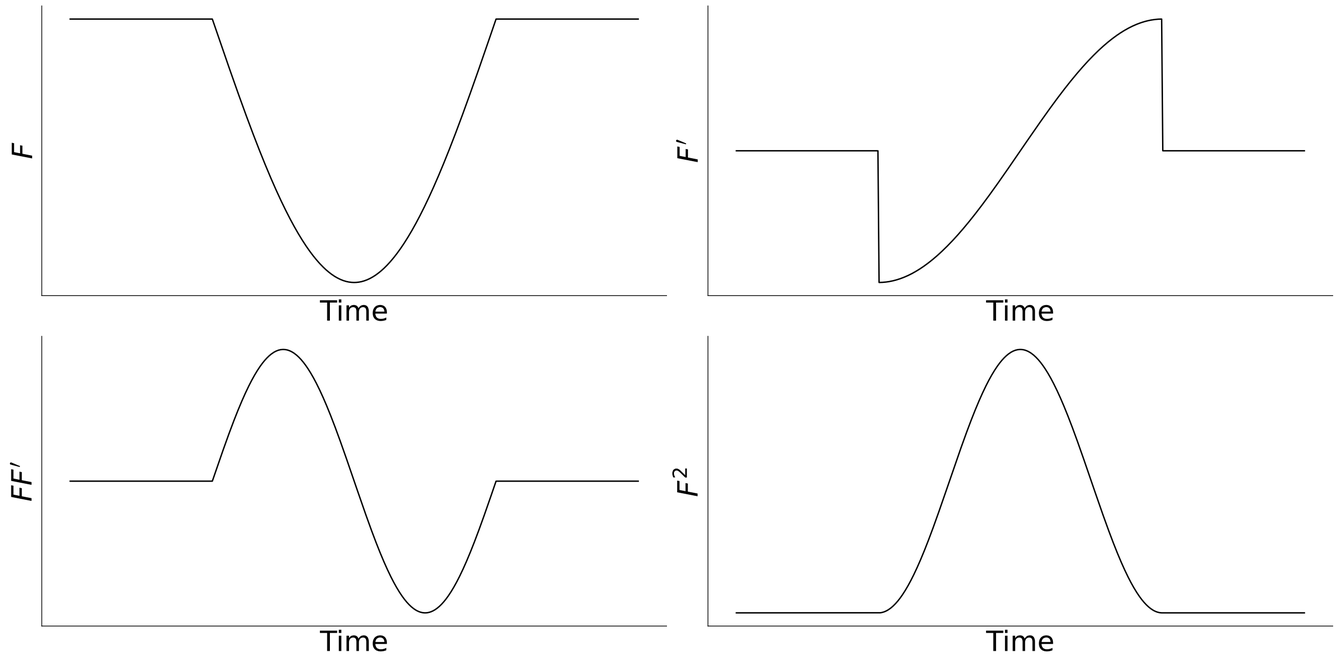


[de Beurs et al. 2020]

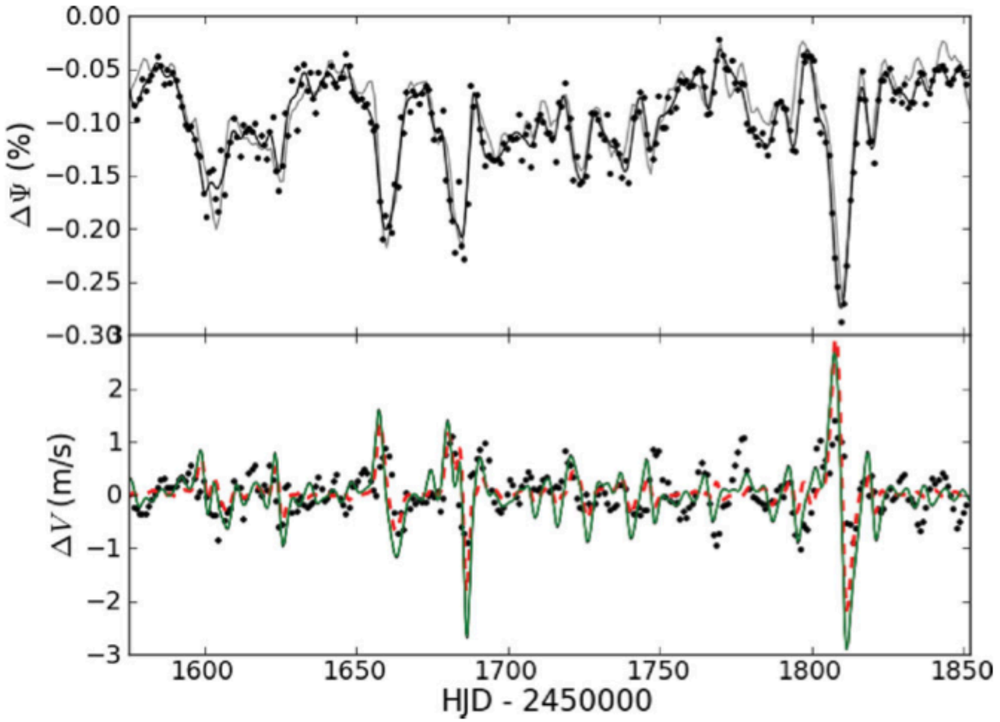
Other proxys : The photometric flux





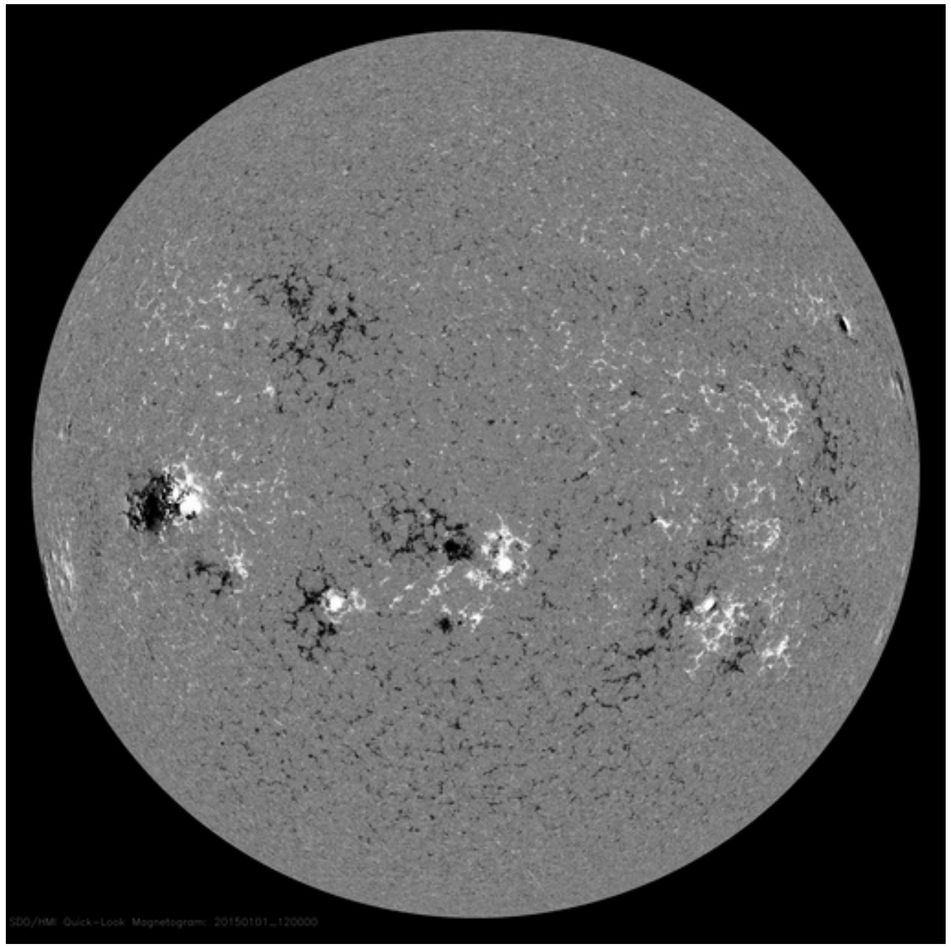


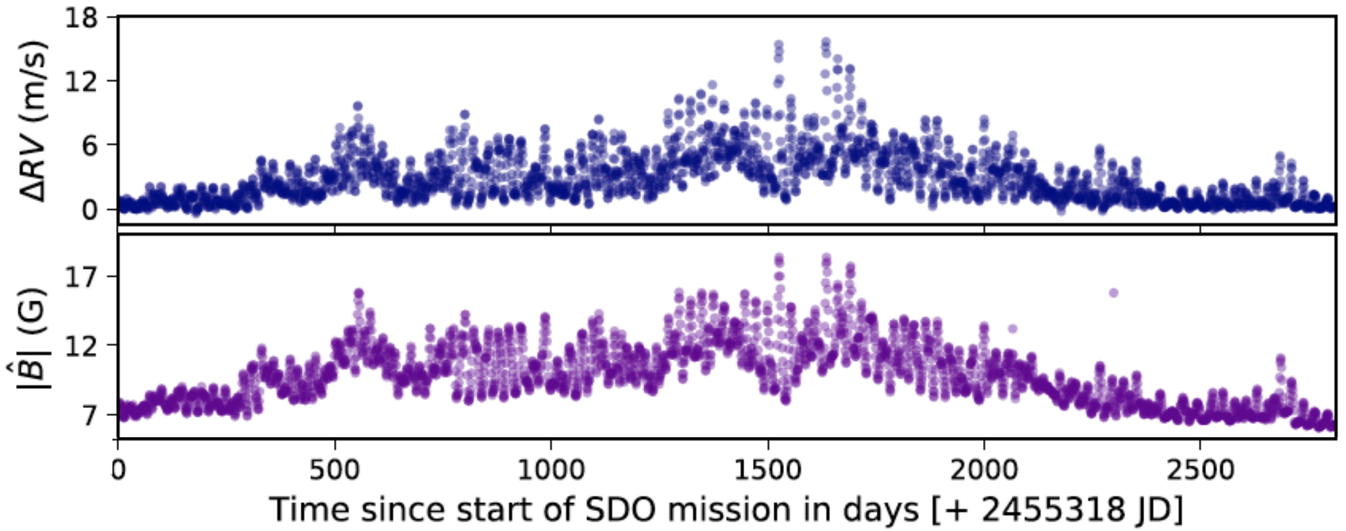
Solar observations + simulations

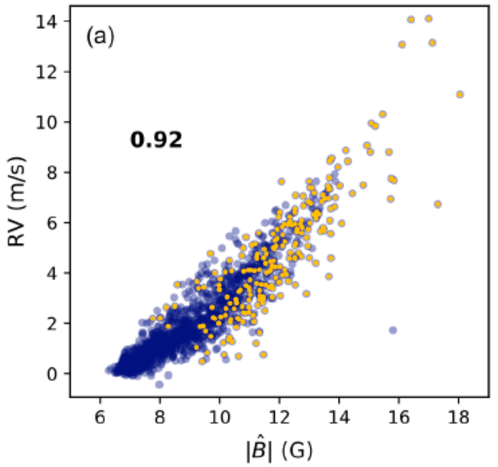


[Aigrain et al. 2012]

Other proxys : The unsigned magnetic flux

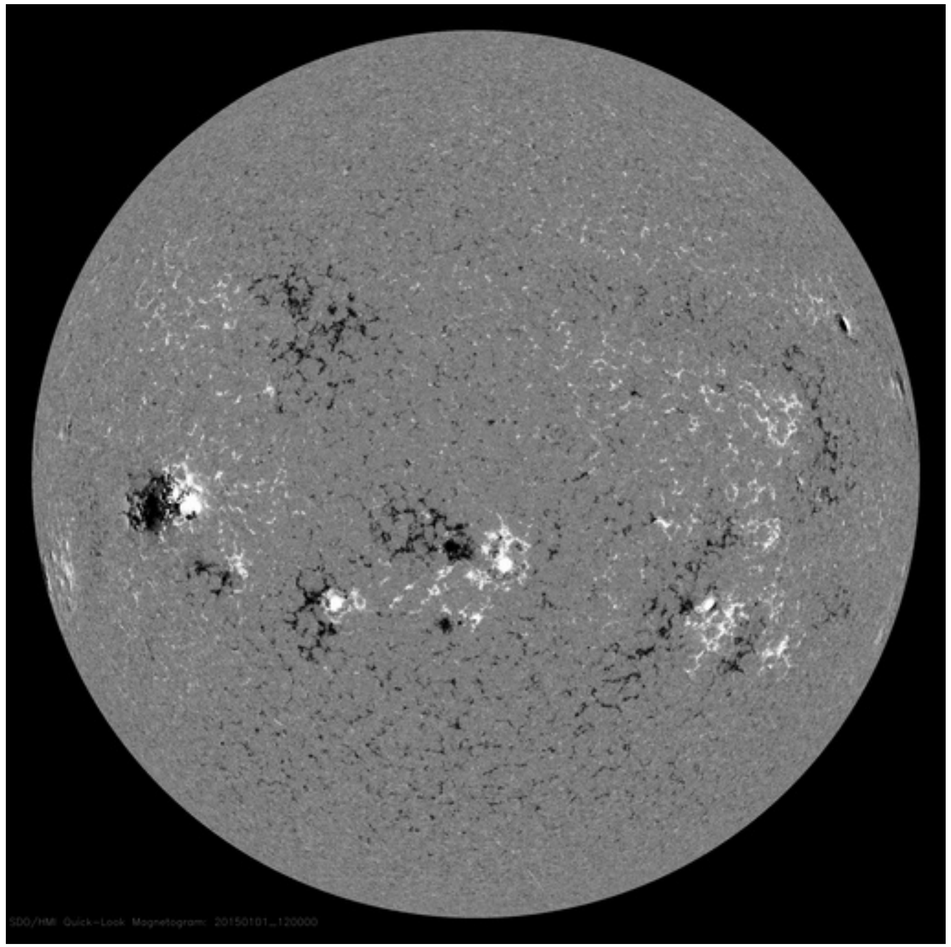


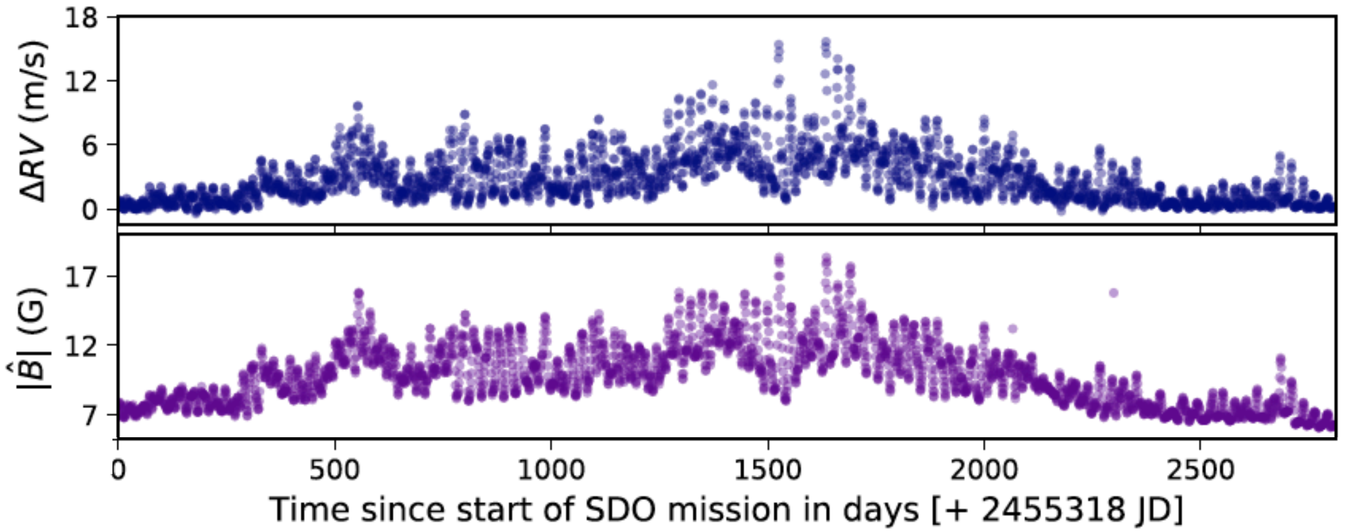


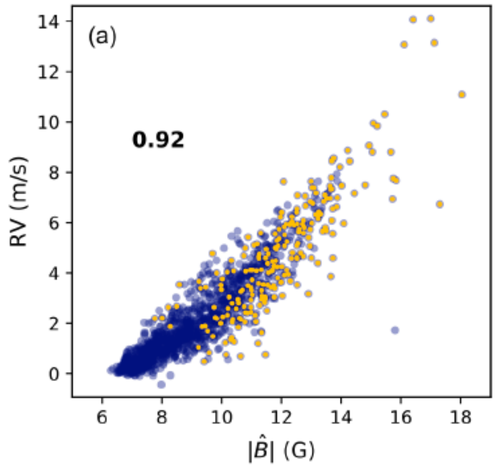


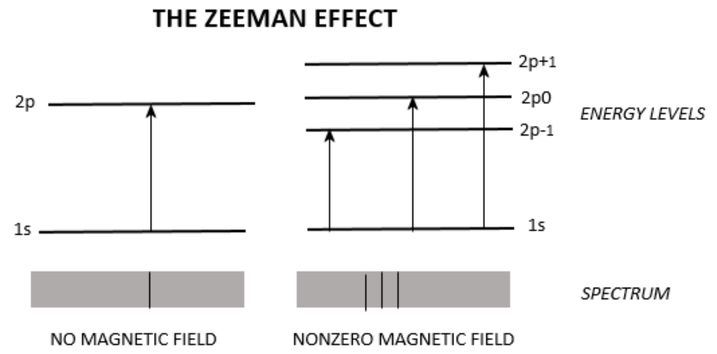
[Reiners et al. 2013; Haywood et al. 2020]

Other proxys : The unsigned magnetic flux









$$\Delta \mathrm{RV} \propto (\lambda\,|\,\hat{B}\,|\,)^2$$

[Reiners et al. 2013; Haywood et al. 2020]

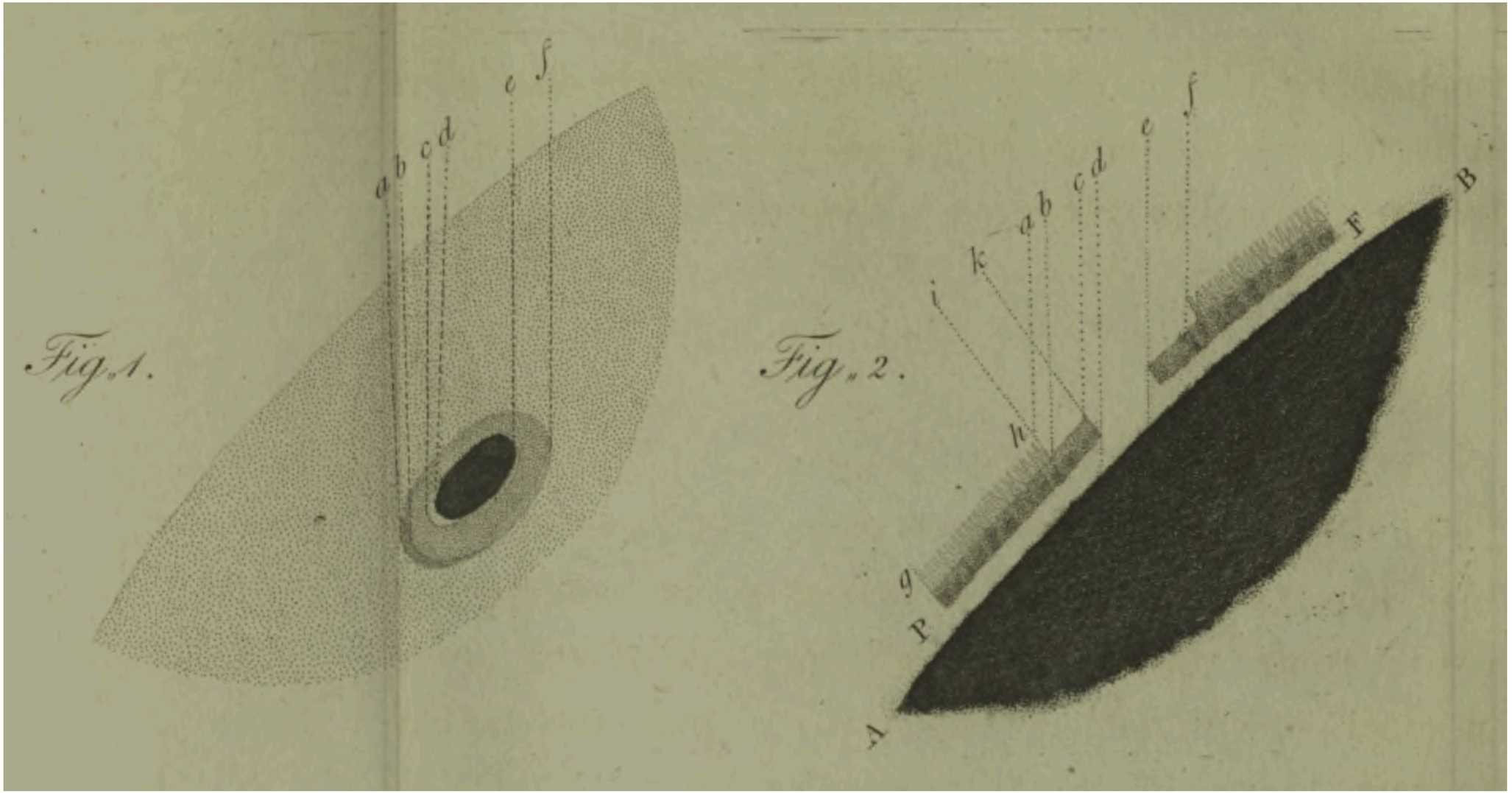
Conclusions

Activity indicators enable us to separate stellar intrinsic signals from planetary ones.

However, the wealth of stellar spectra is boiled down to a few (manageable) quantities.

The Sun—resolved and continuously observed—is ideal for benchmarking the validity of proxies.

Life *inside* the Sun?



[Herschel 1801]