

Determining Starspot Lifetimes from Photometry to Feed Models of Stellar Activity in Exoplanet RV Surveys



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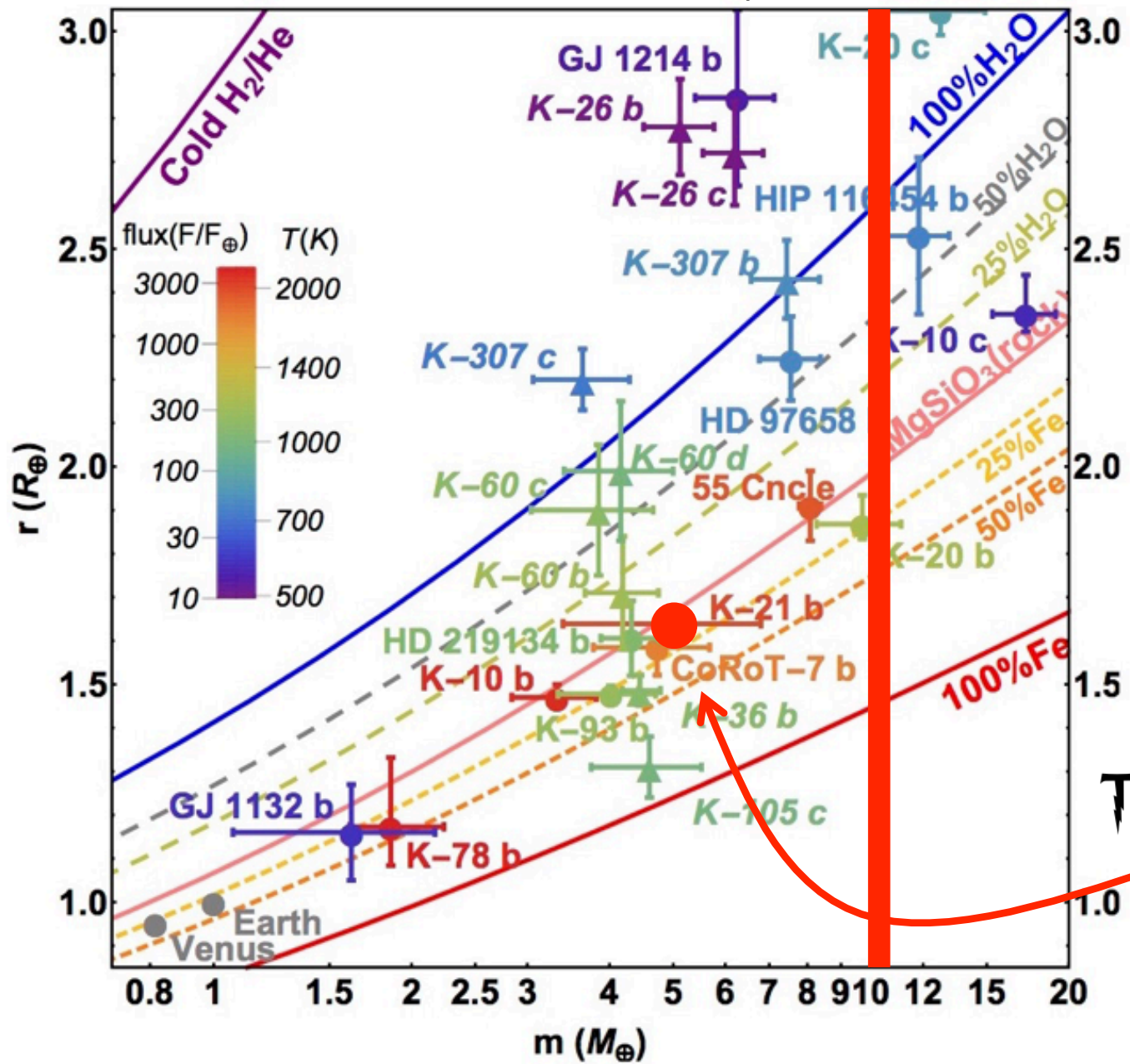


Andrew Collier Cameron - University of St Andrews

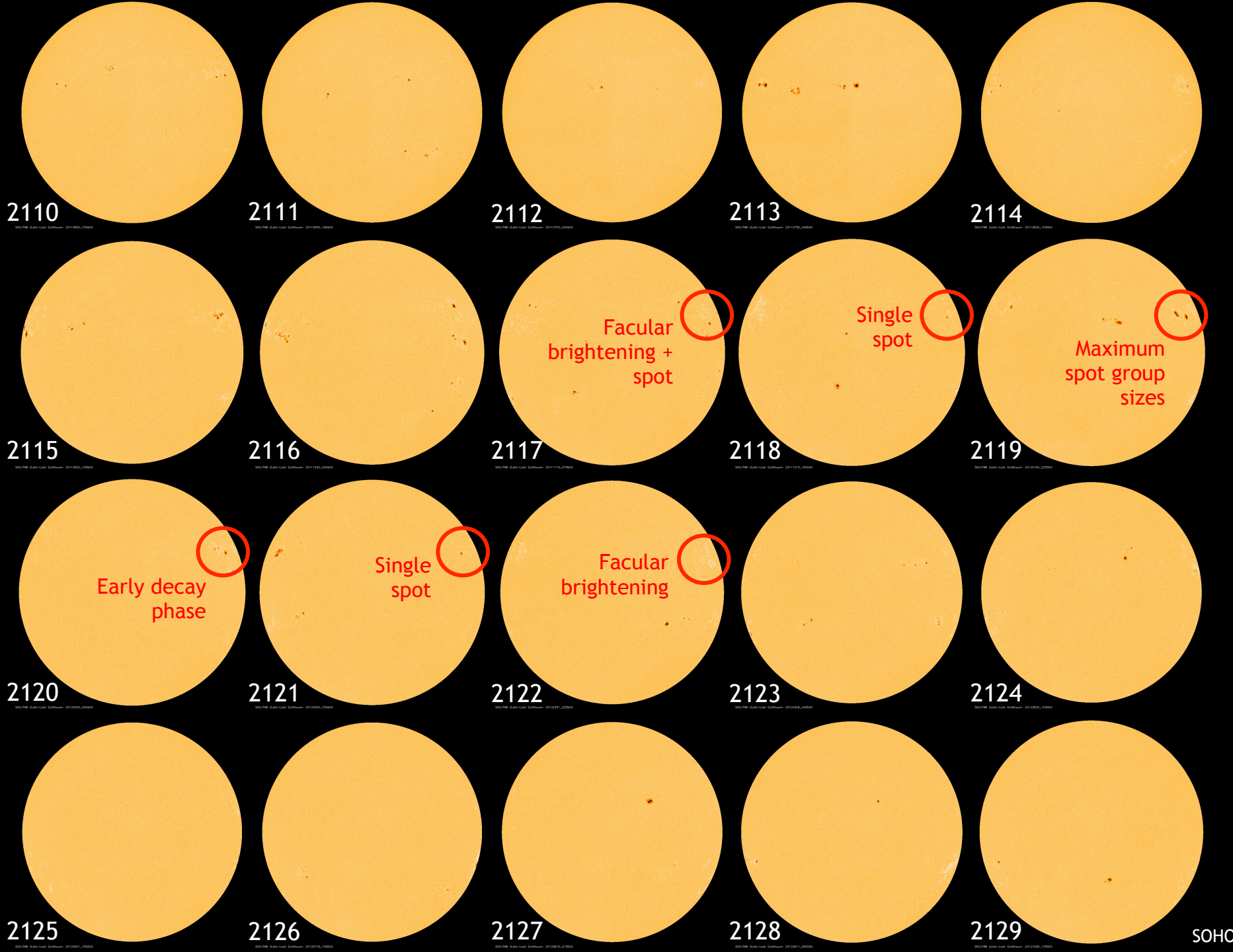


Raphaëlle Haywood - CfA

Video from the Institute for
Solar Physics of the
Royal Swedish Academy



The Chosen One



2110

2111

2112

2113

2114

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Facular
brightening +
spot

Single
spot

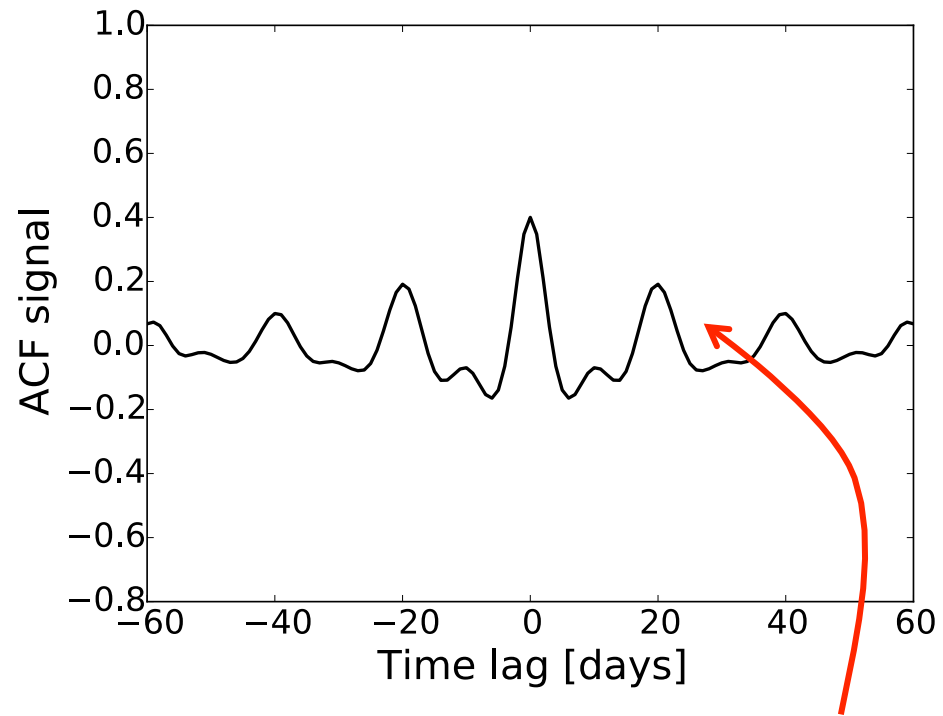
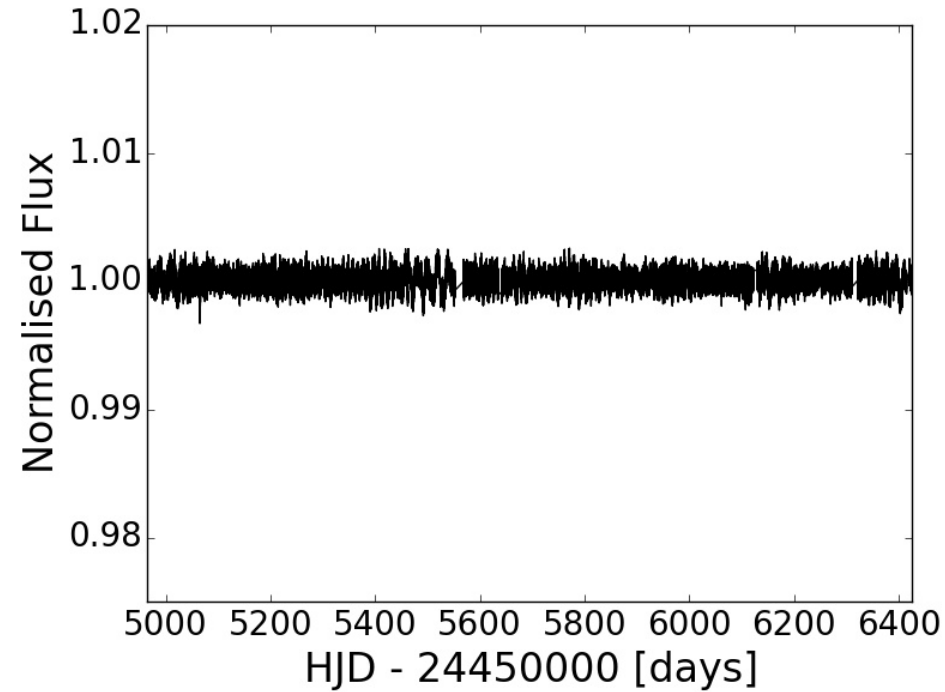
Maximum
spot group
sizes

Early decay
phase

Single
spot

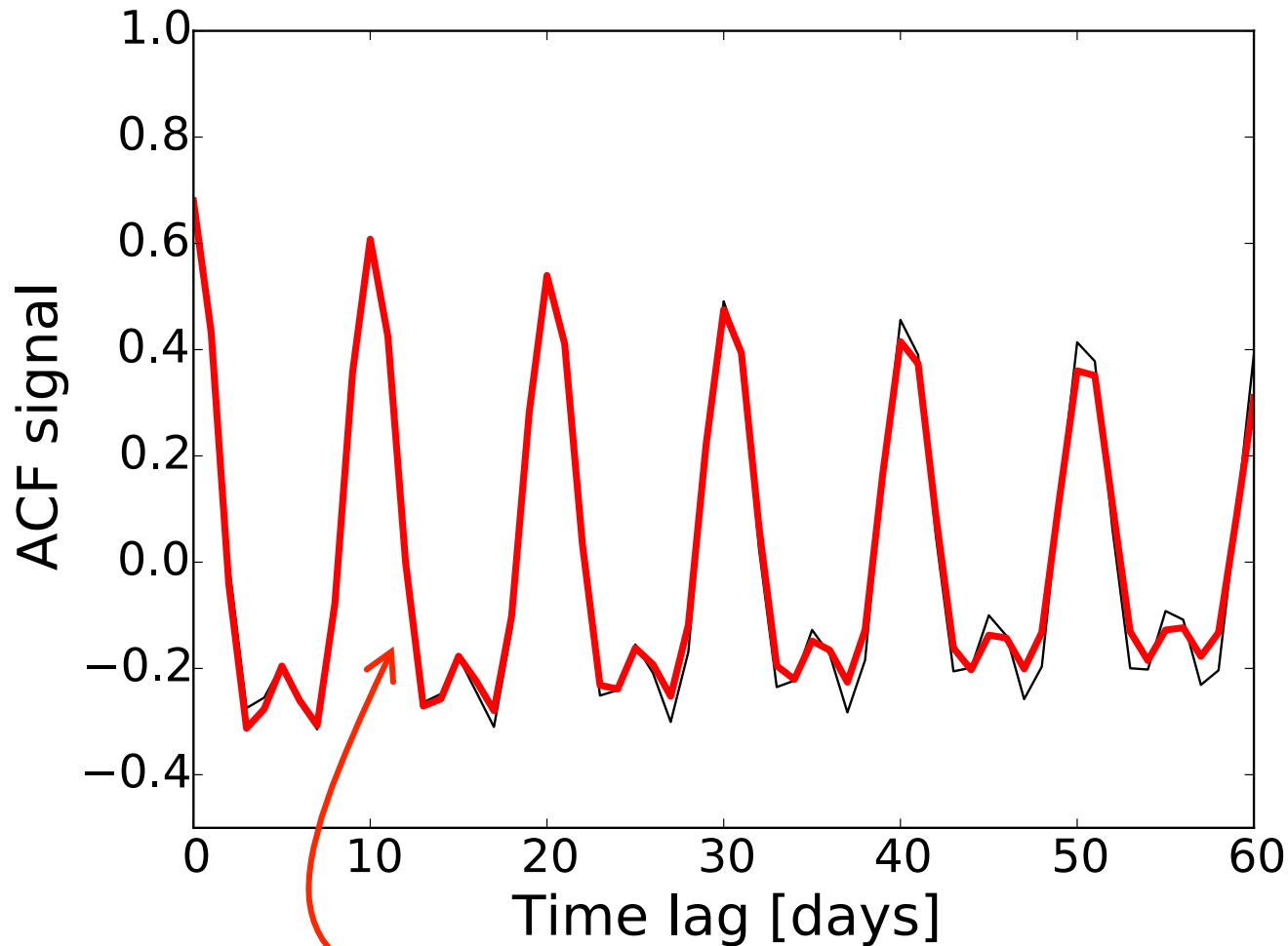
Facular
brightening

Kepler Light Curves



*Measure stellar
rotation period
McQuillan et al. (2014)*

Fitting the ACF



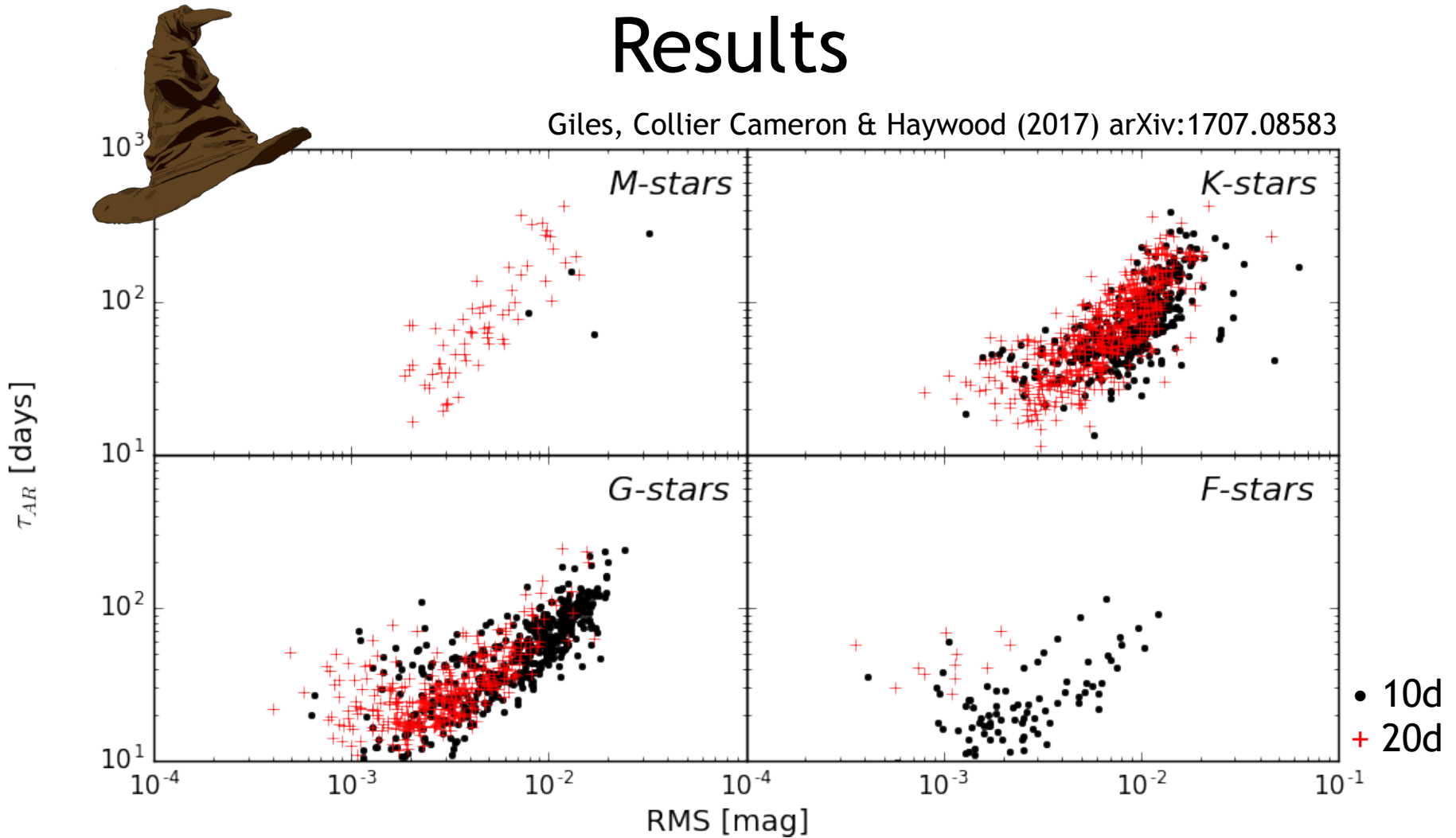
*Under-damped
simple harmonic
motion!
(AKA 1st year
physics)*



$$y = \exp\left(-\frac{t}{\tau}\right) \left[A \cos\left(\frac{2\pi t}{P}\right) + B \cos\left(\frac{4\pi t}{P}\right) + y_0 \right]$$

Results

Giles, Collier Cameron & Haywood (2017) arXiv:1707.08583

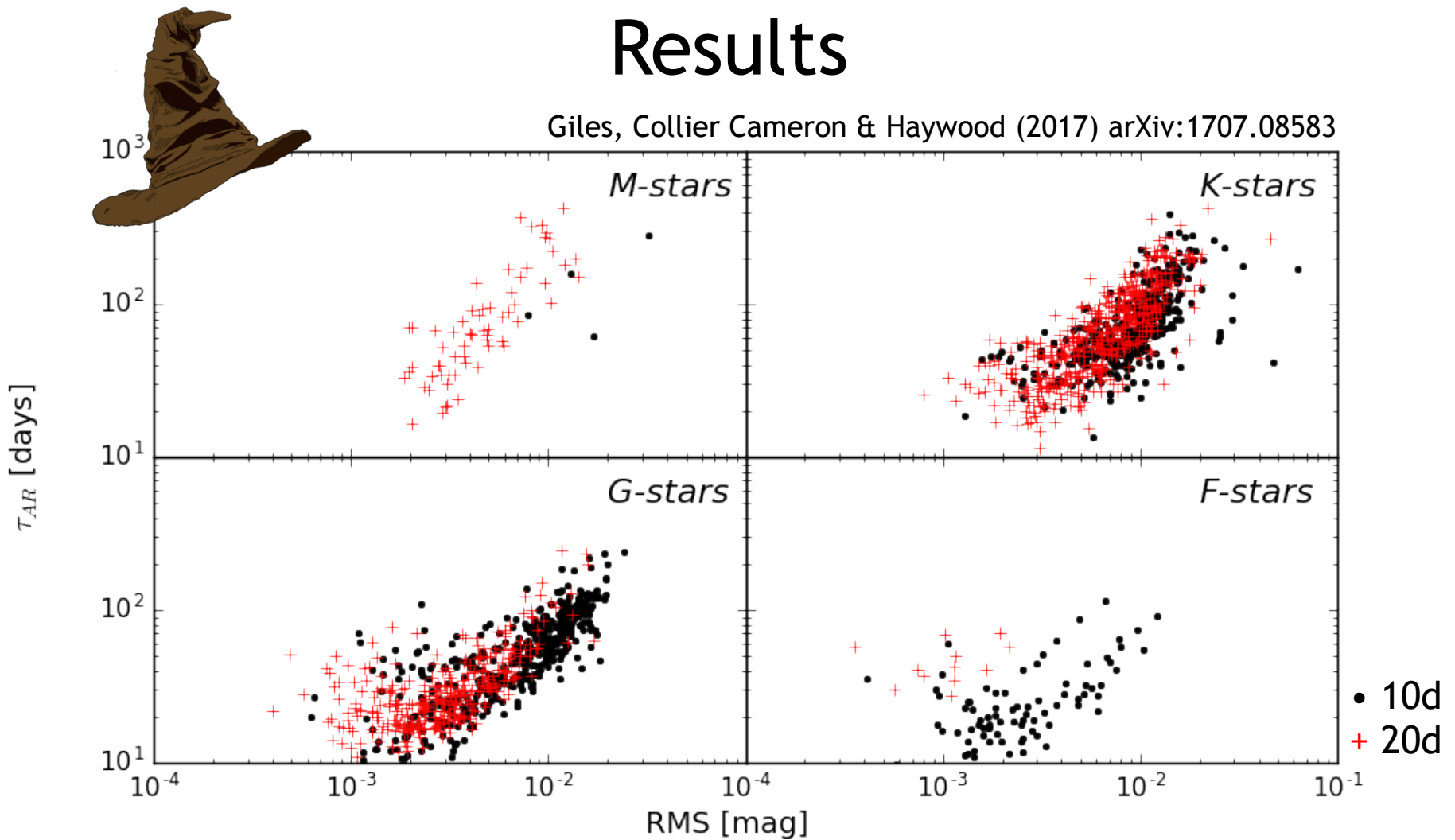


Key points!

1. Big spots live longer.
2. Spots of a given size live longer on cooler stars.

Results

Giles, Collier Cameron & Haywood (2017) arXiv:1707.08583



Estimate the spot lifetime with

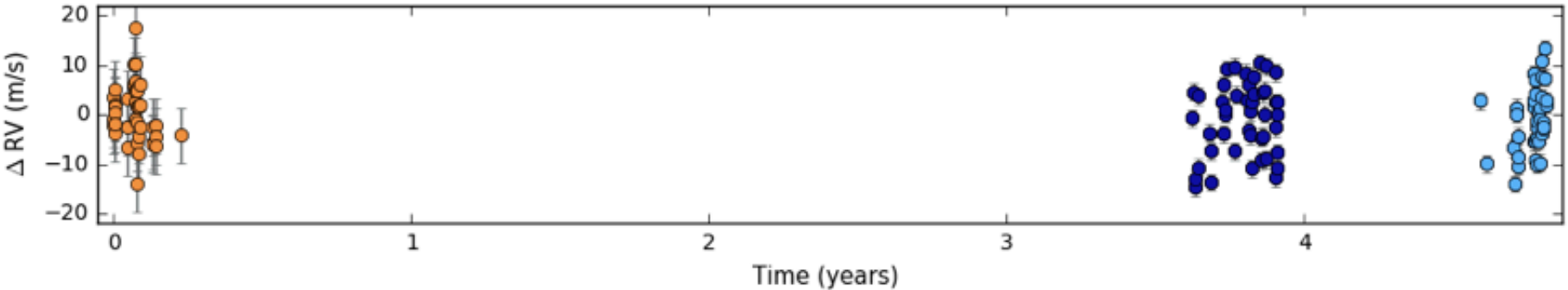
$$\log_{10} \tau_{AR} = 10.9252 + 3.0123 \log_{10} rms + 0.5062 (\log_{10} rms)^2 - 1.3606 \log_{10} T_{eff}$$

(with error of... $\sigma (\log_{10} \tau_{AR}) = 0.178623$)

What does this have to do with Exoplanets?

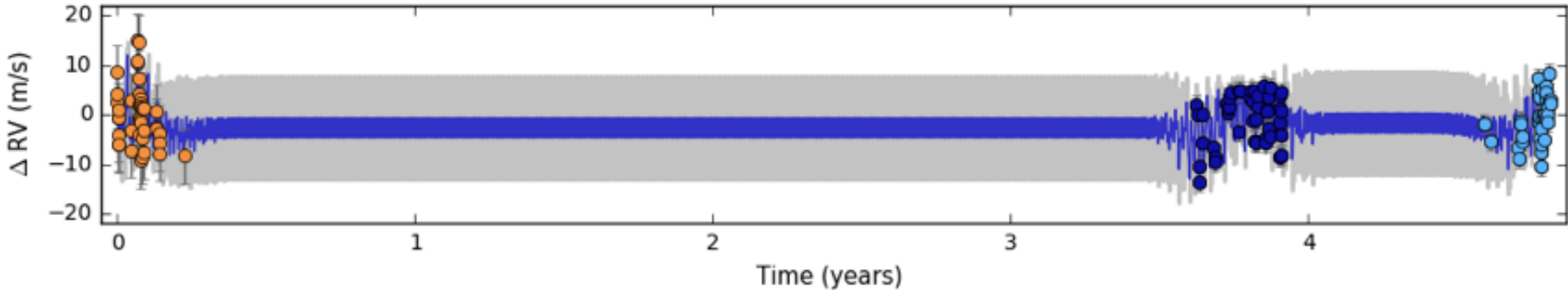
(i.e. Why on Earth am I here?)

López-Morales et al. 2016

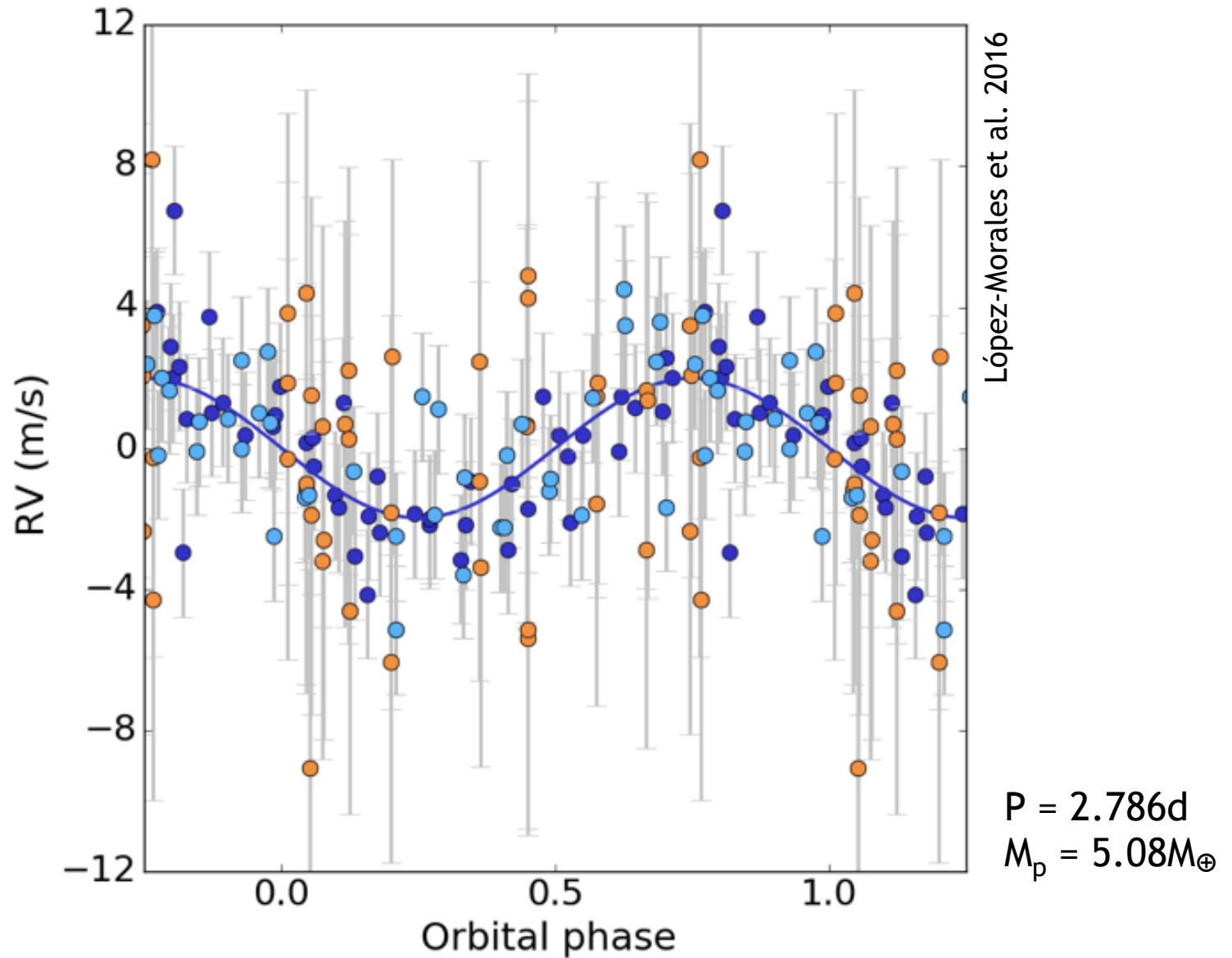


K-21: Very active, very bright star from *Kepler*
Hosts a $1.6R_{\oplus}$ planet on a 2.7d orbit
Mass estimated to be $<10M_{\oplus}$ by Howell et al. 2012

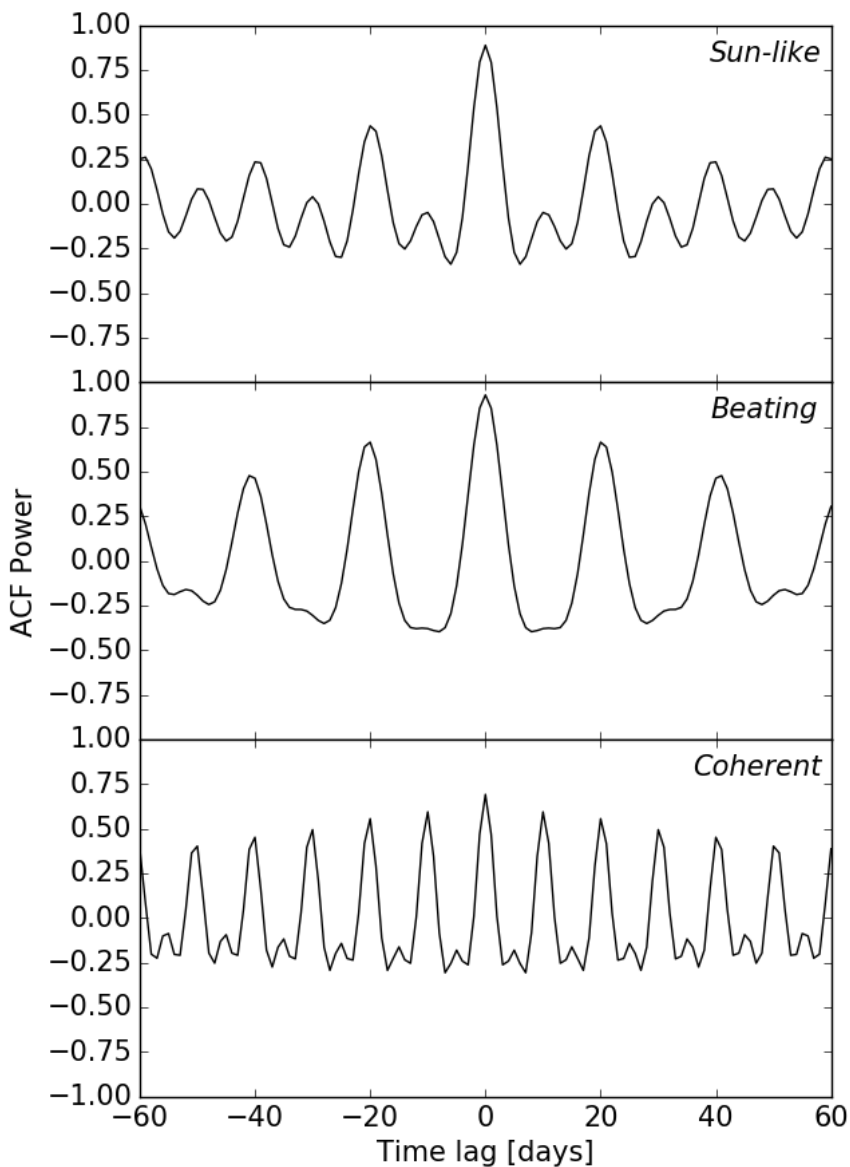
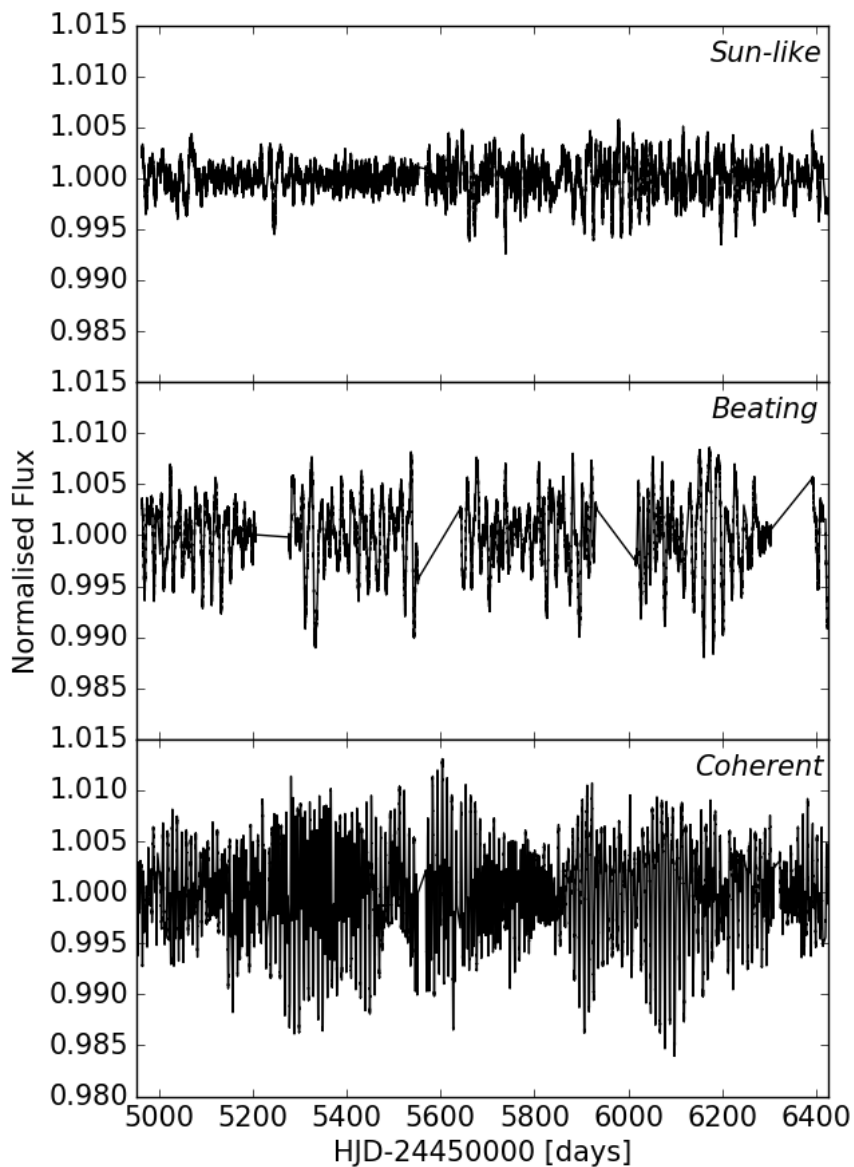
López-Morales et al. 2016



Kepler-21b



How best to schedule your RV Follow-up



That's All Folks

Measured starspot decay lifetimes of *Kepler* F-, G-, K-, M-stars
(uSHO fit to ACF with MCMC)

- ☆ Bigger spots live longer
- ☆ Spots live longer on cooler stars
- ☆ Possibility to estimate the spot decay lifetime of a star

arXiv:1707.08583

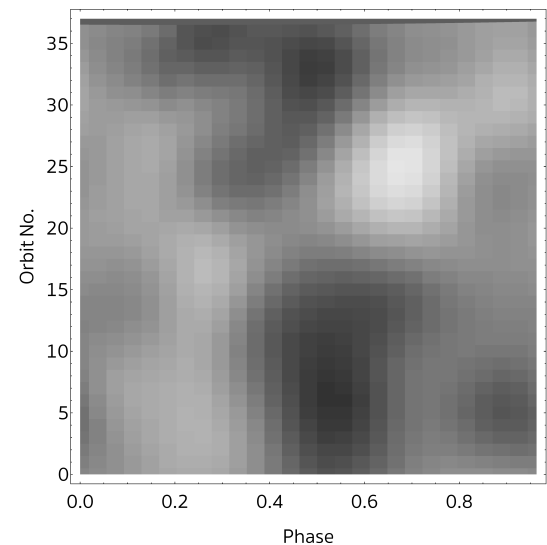
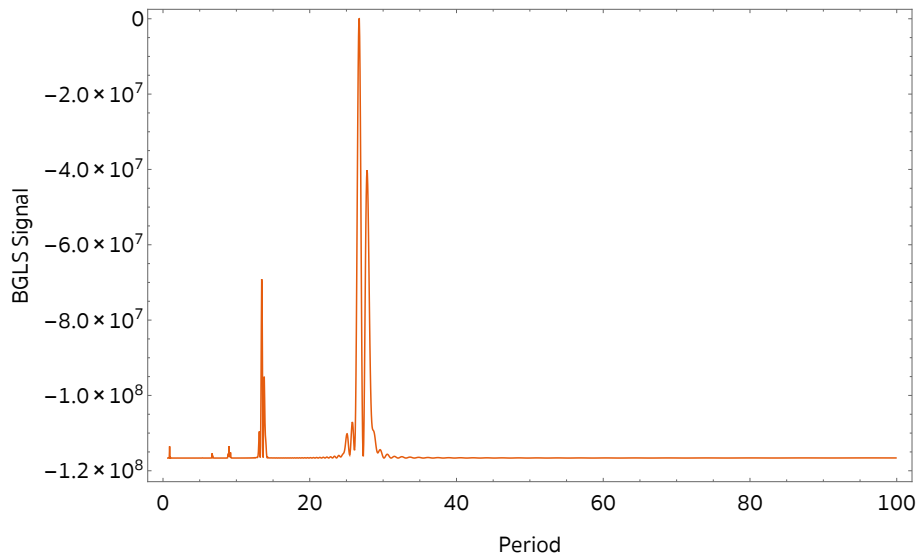
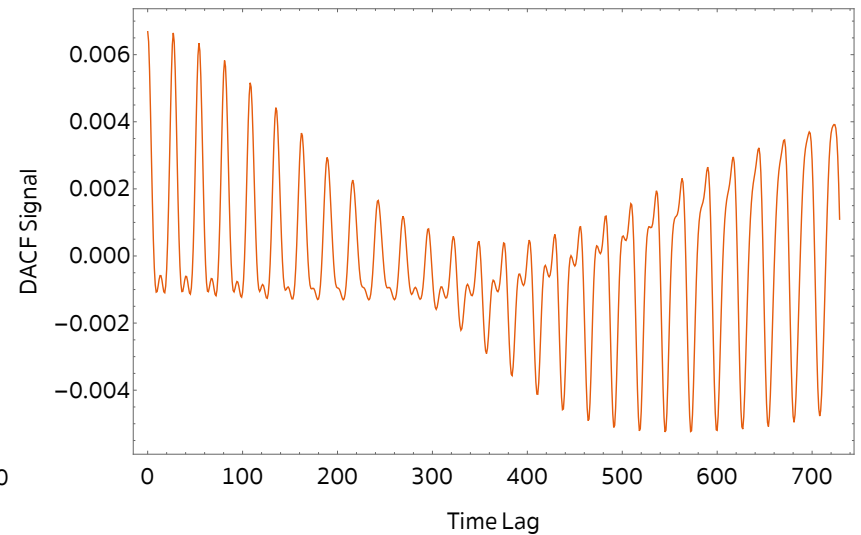
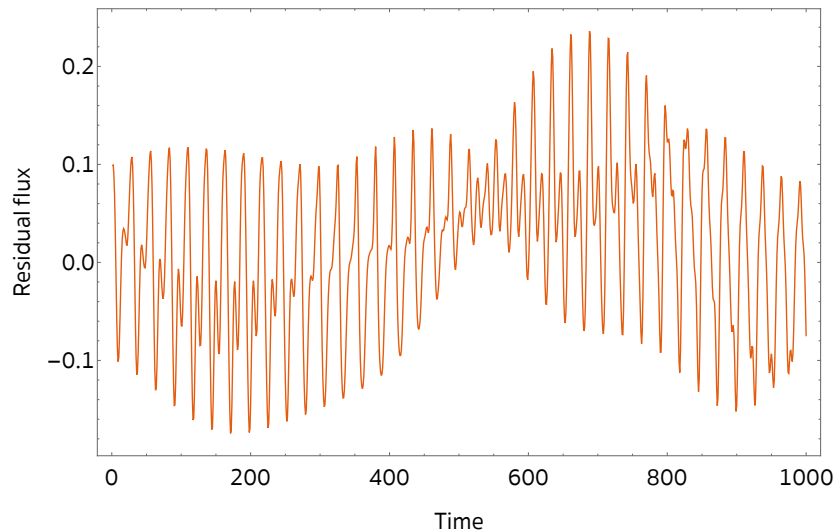
Stellar rotation periods and decay lifetimes used as priors for GPs

Tactics for RV follow-up scheduling based on spot lifetimes

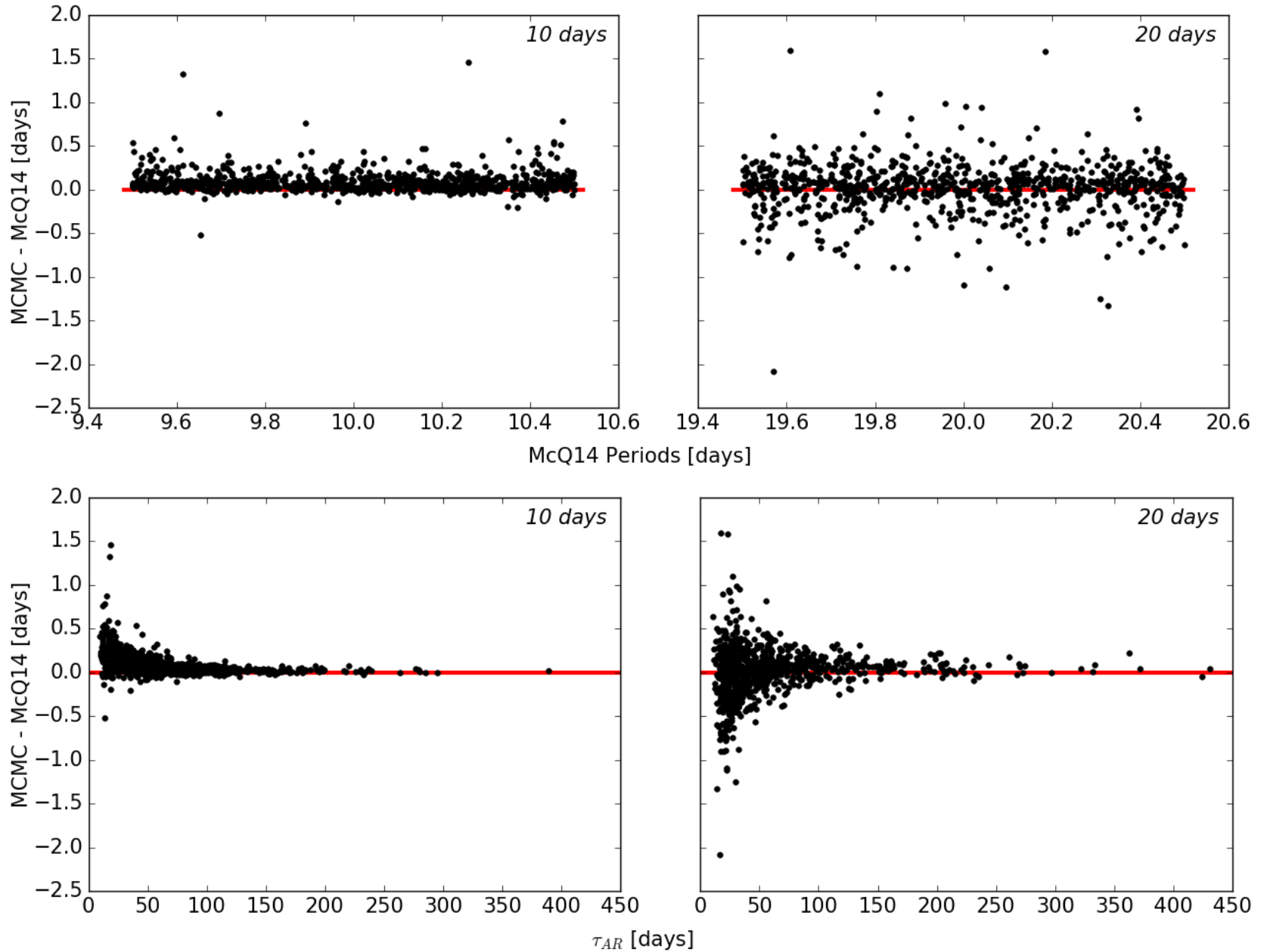
Back-Up Slides



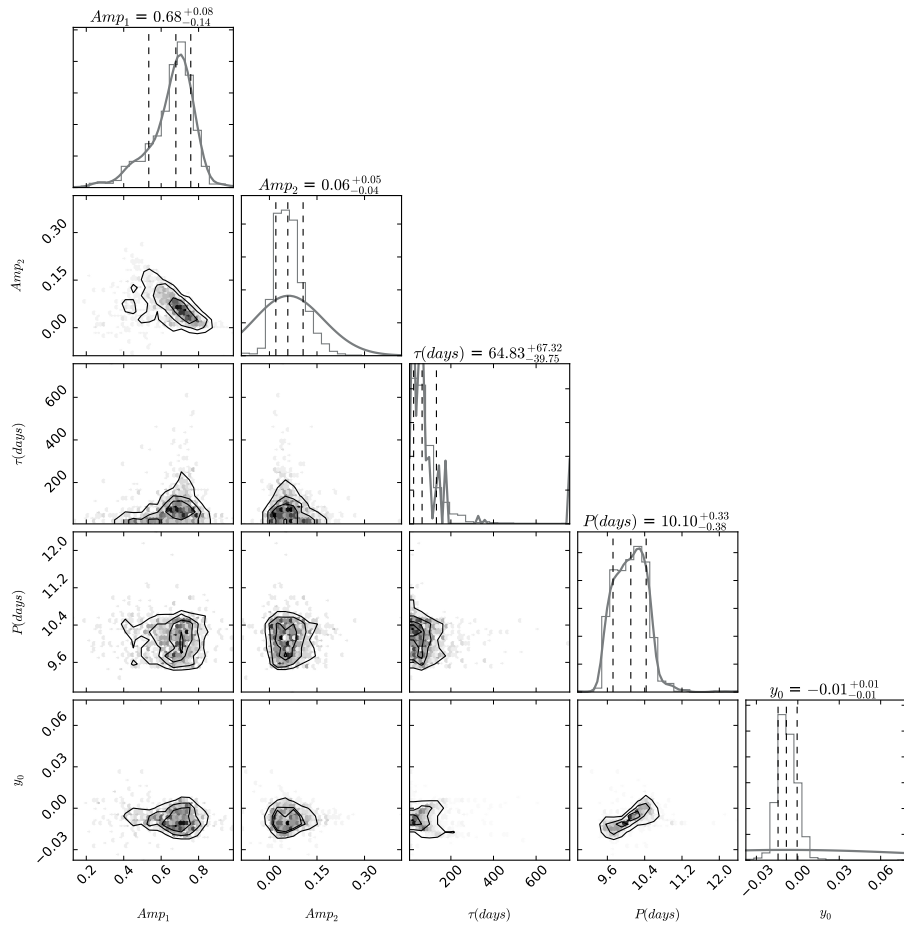
Falsely Detecting Differential Rotation in a GP Generated Light Curve



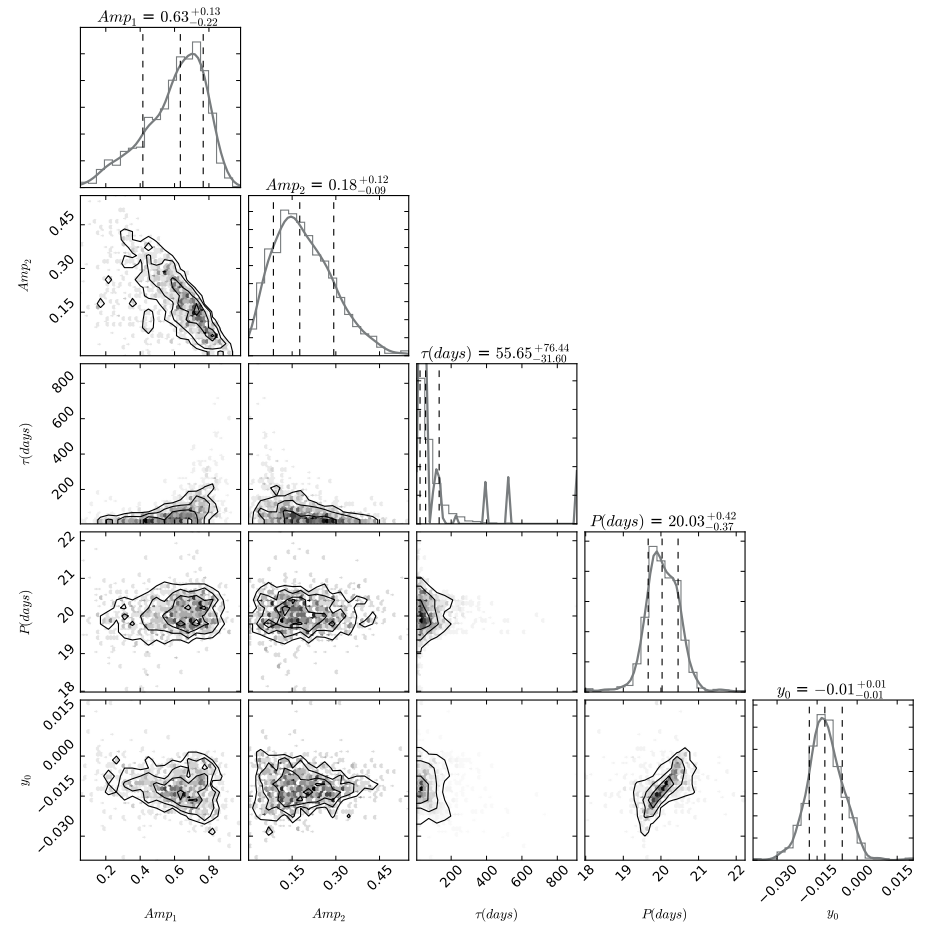
Period Comparison with McQ14



Correlation between parameters



10 day period stars



20 day period stars