

Comprehensive analysis of simultaneous photometric and spectro-polarimetric data in a young Sun-like star: Rotation period, variability, activity & magnetism ...

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MPS



MAX-PLANCK-GESELLSCHAFT

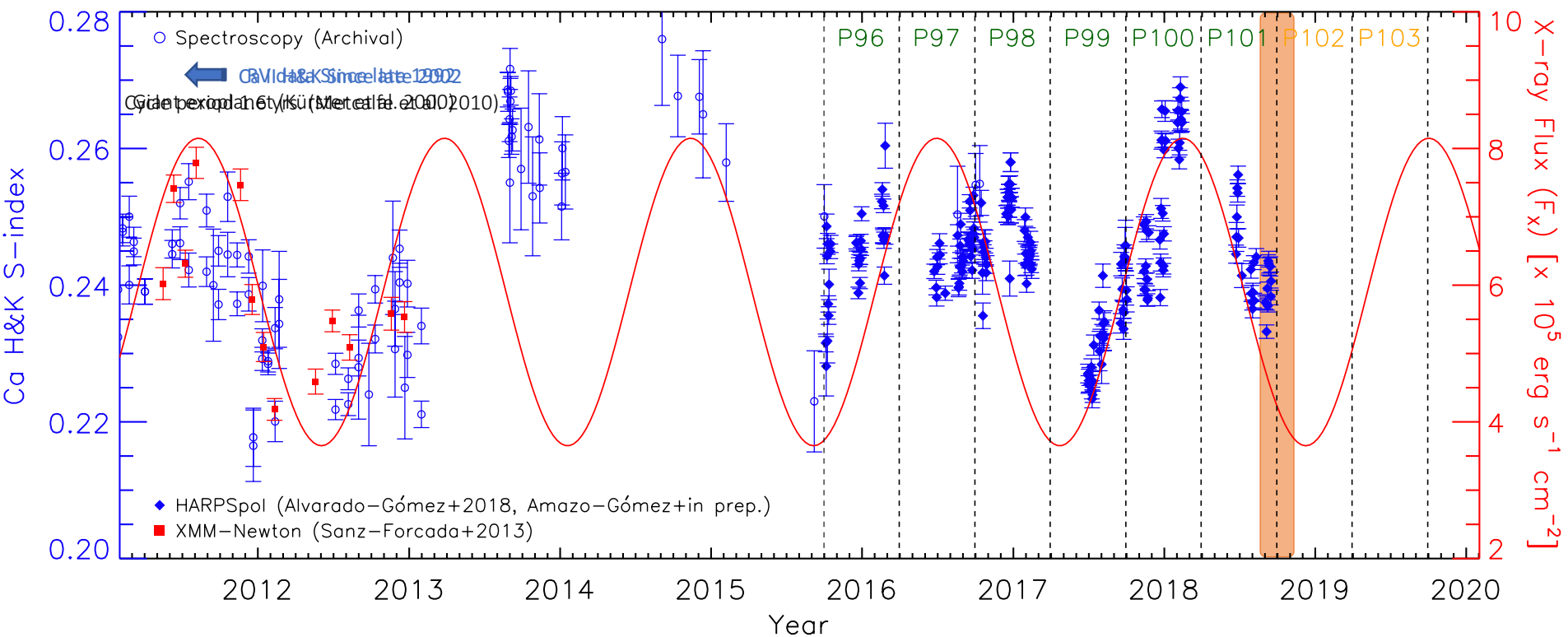
SOLVe



CENTER FOR
ASTROPHYSICS
HARVARD & SMITHSONIAN

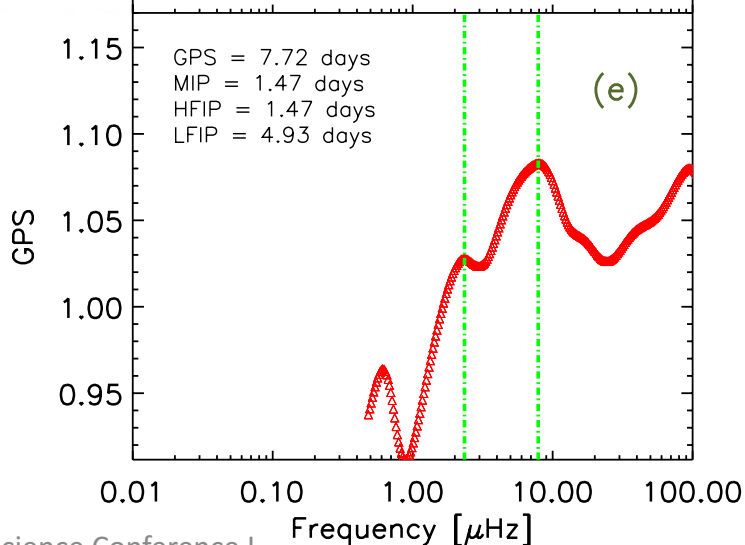
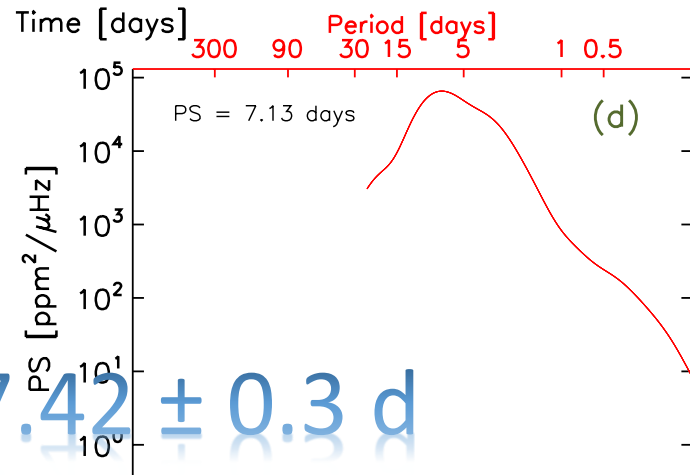
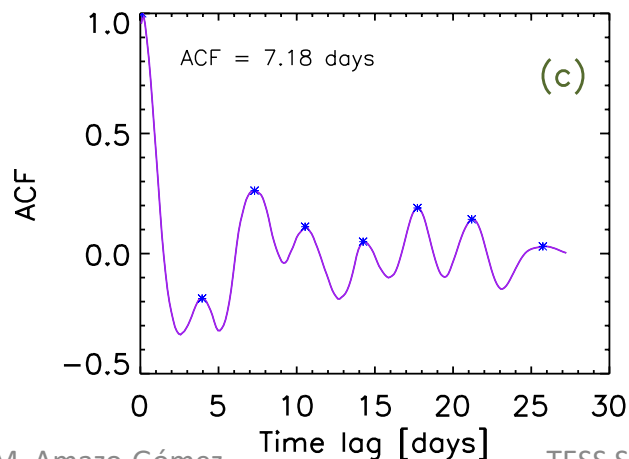
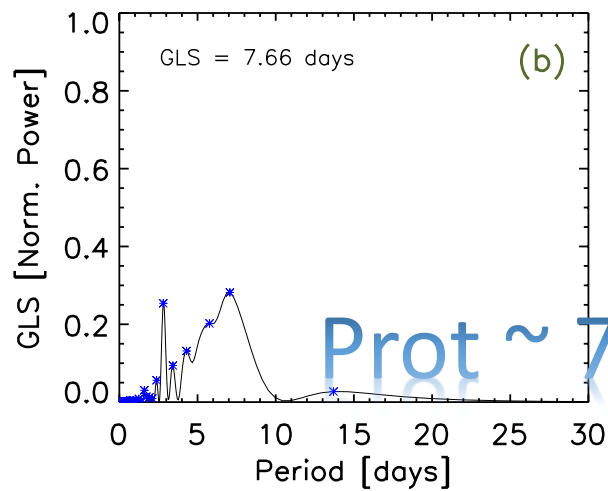
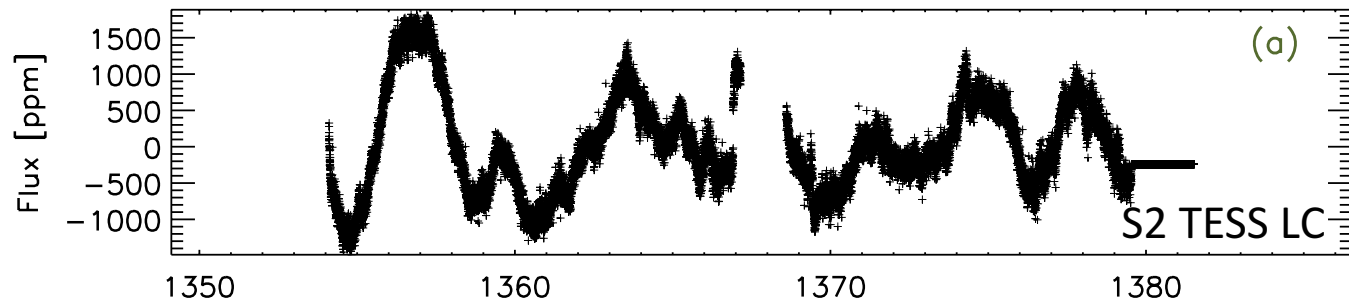
IOTA HOROLOGII: FAR BEYOND THE SUN CAMPAIGN

LONG TERM SIMULTANEOUS MULTI-TECHNIQUE MULTI-WAVELENGTH FOLLOW UP



- Coronal X-rays (XMM-Newton - poster #68 S. Raetz)
- Astrosphere (HST)
- Chromospheric, Magnetic Field, RV, Age, Inclination (HARPSpol)
- Rotation period, Gyrochronology, F/S (TESS)

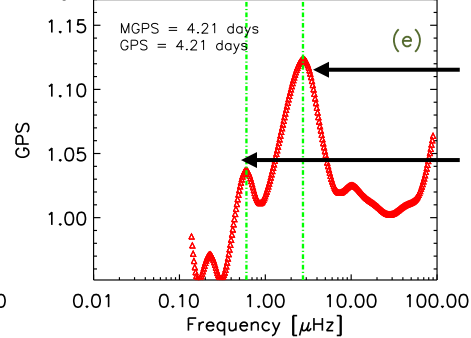
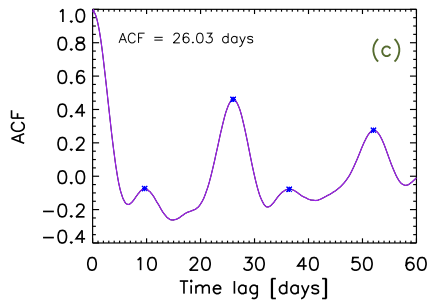
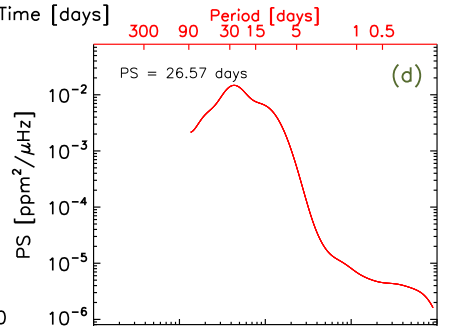
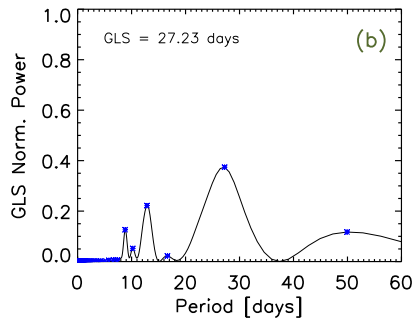
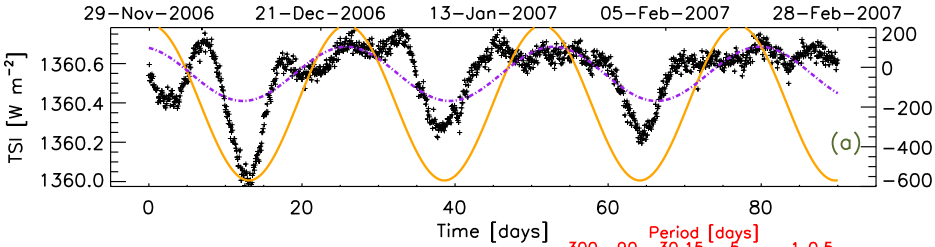
ROTATION PERIOD ANALYSIS



Prot $\sim 7.42 \pm 0.3$ d

SOLAR CASE FOR PSEUDO-ISOLATED MAGNETIC FEATURES

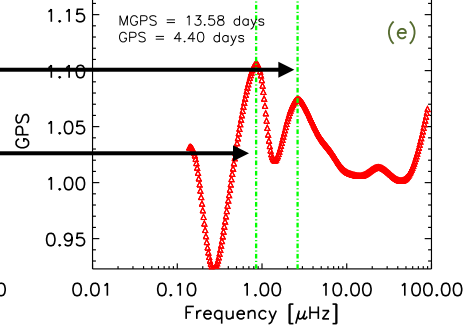
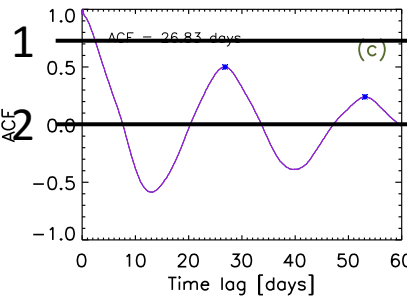
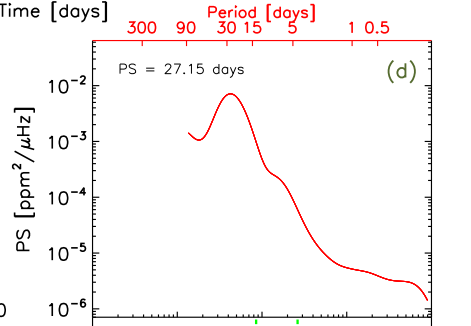
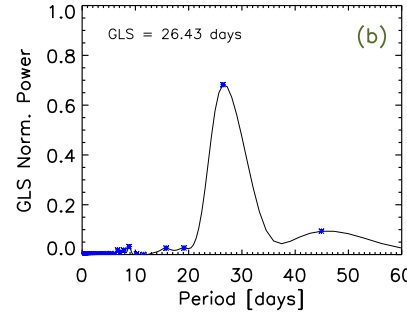
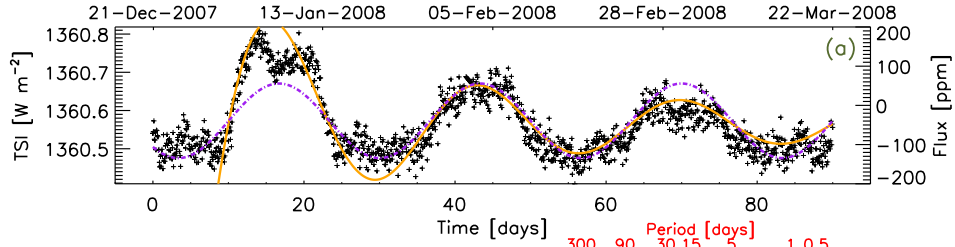
Spots



$$\text{Prot} = 26.65 \pm 2.368 \text{ d}$$

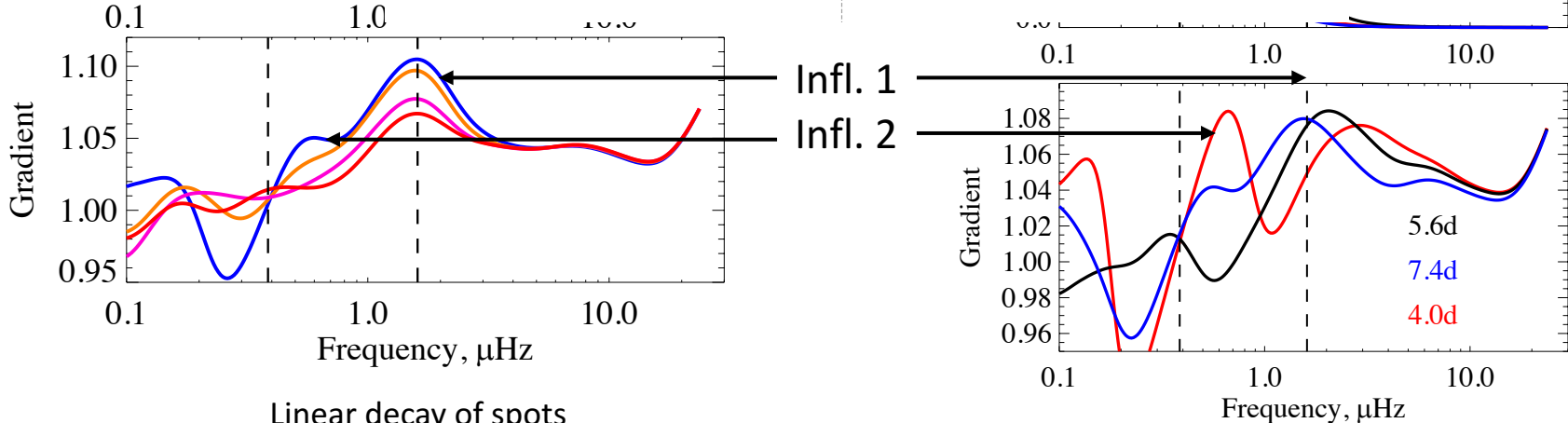
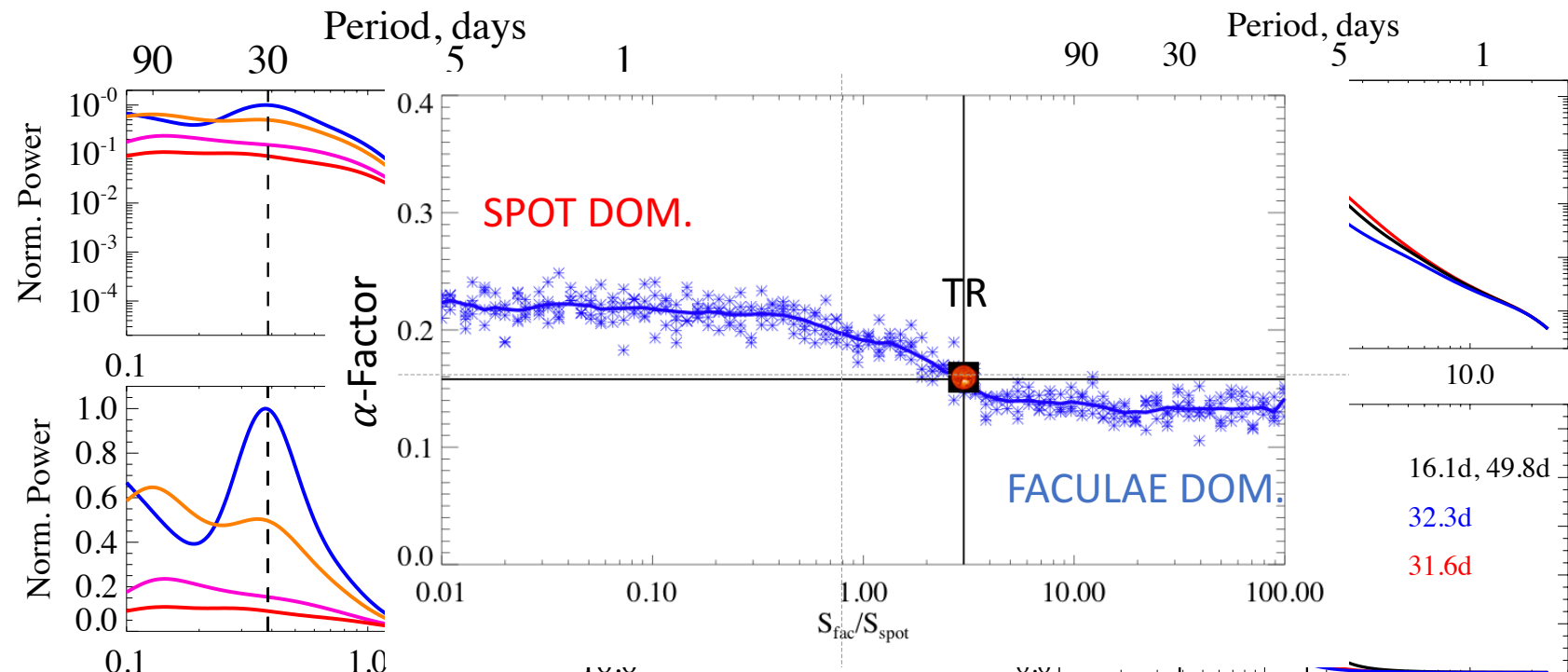
TSI: TIM/SORCE Observations

Facular region



$$\text{Prot} = 27.84 \pm 2.47 \text{ d}$$

Amazo-Gómez et al. Submitted

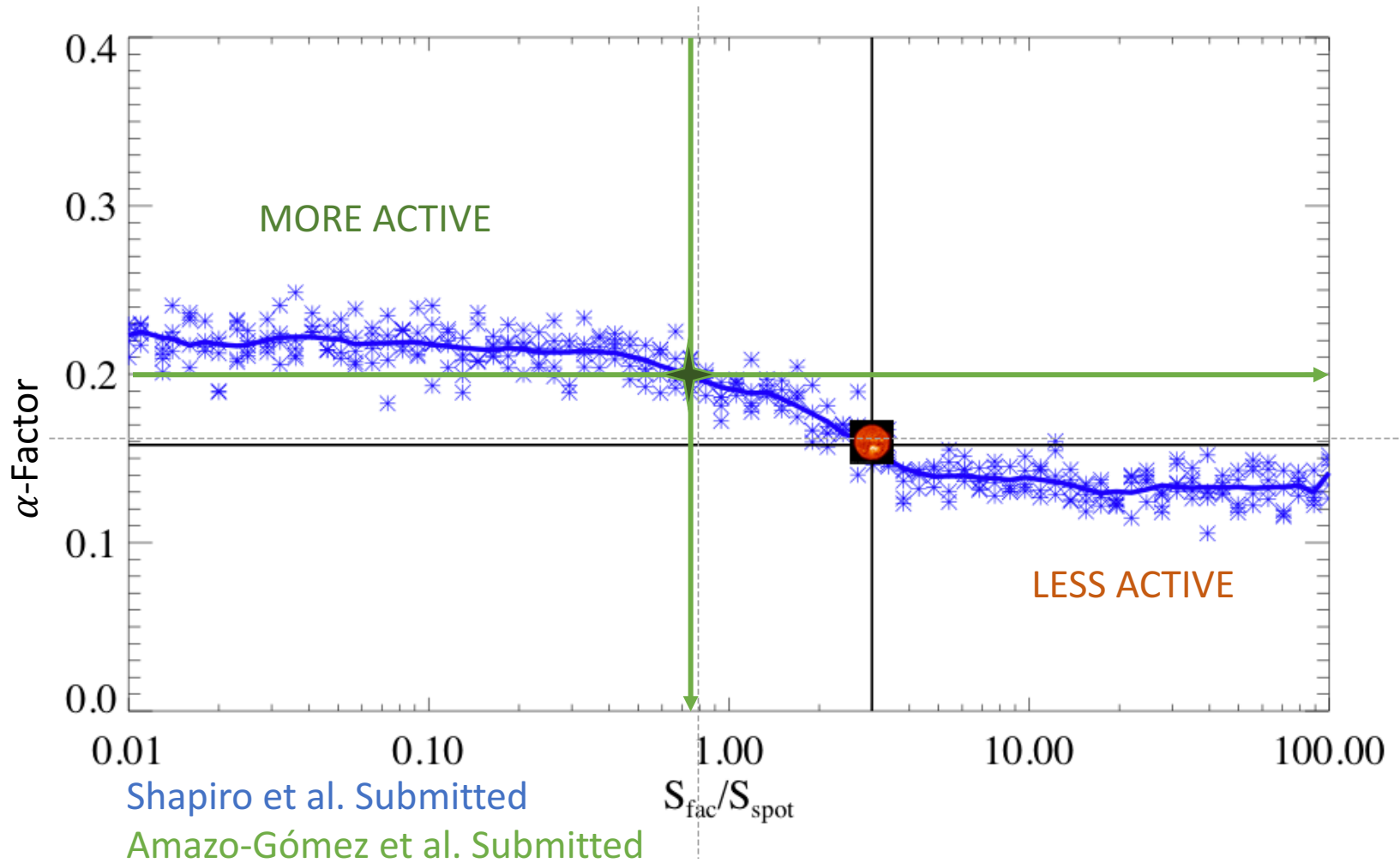


Linear decay of spots
 Lifetime: 90 d, 50d, 20d, 12d

- Spot component of variability
 - Facular component of variability
 - Total variability

Shapiro, Amazo-Gómez et al. Submitted

FACULAE TO SPOT RATIO



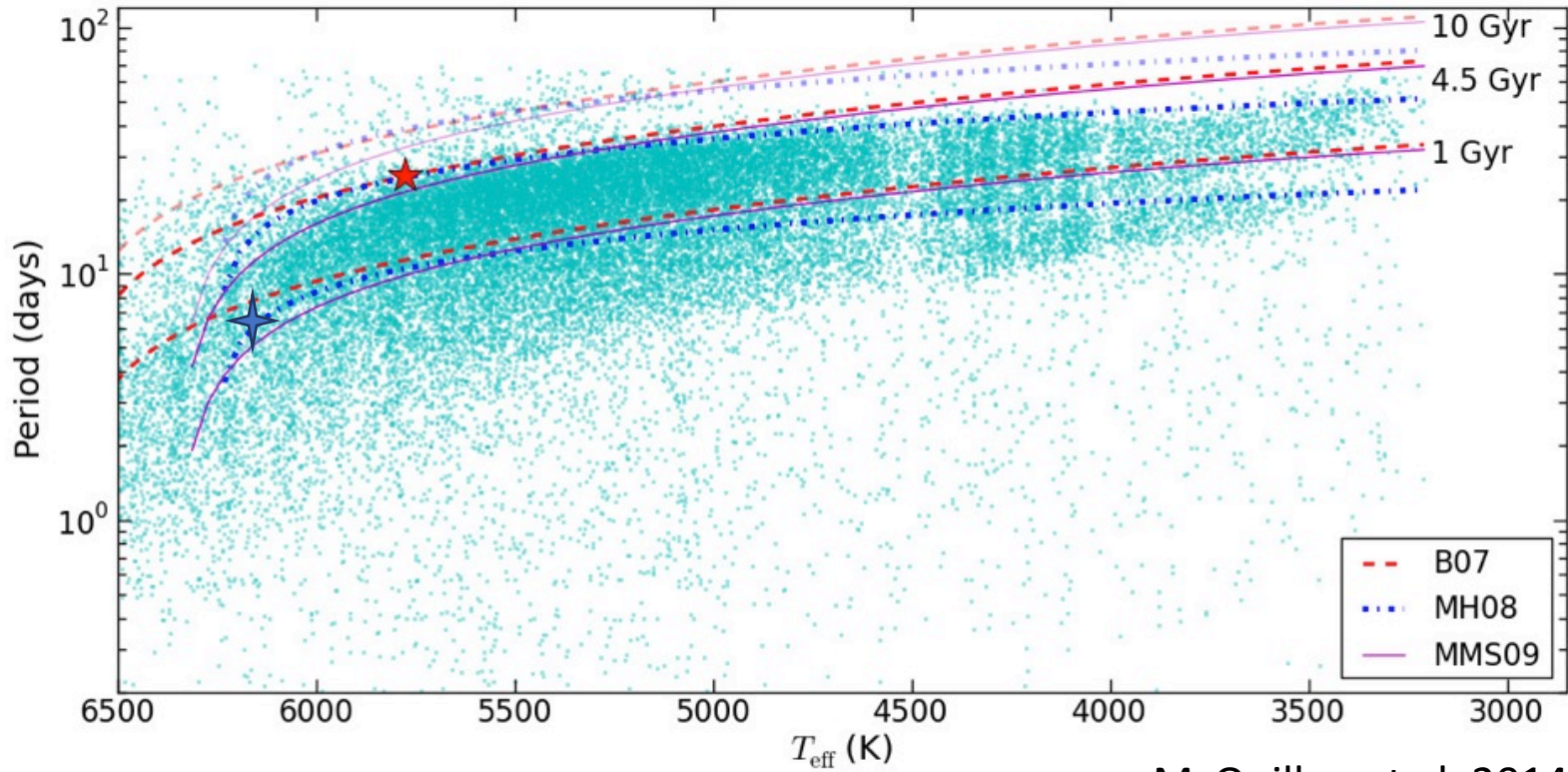
$$\alpha_{\odot} = IP_{GPS}/Prot = 0.158$$

$$\alpha_{tHor} = 0.191$$

Faculae/Spot_⊙ ratio ~ 3

$$F/S_{tHor} \sim 0.74$$

GYROCHRONOLOGY APPROACH

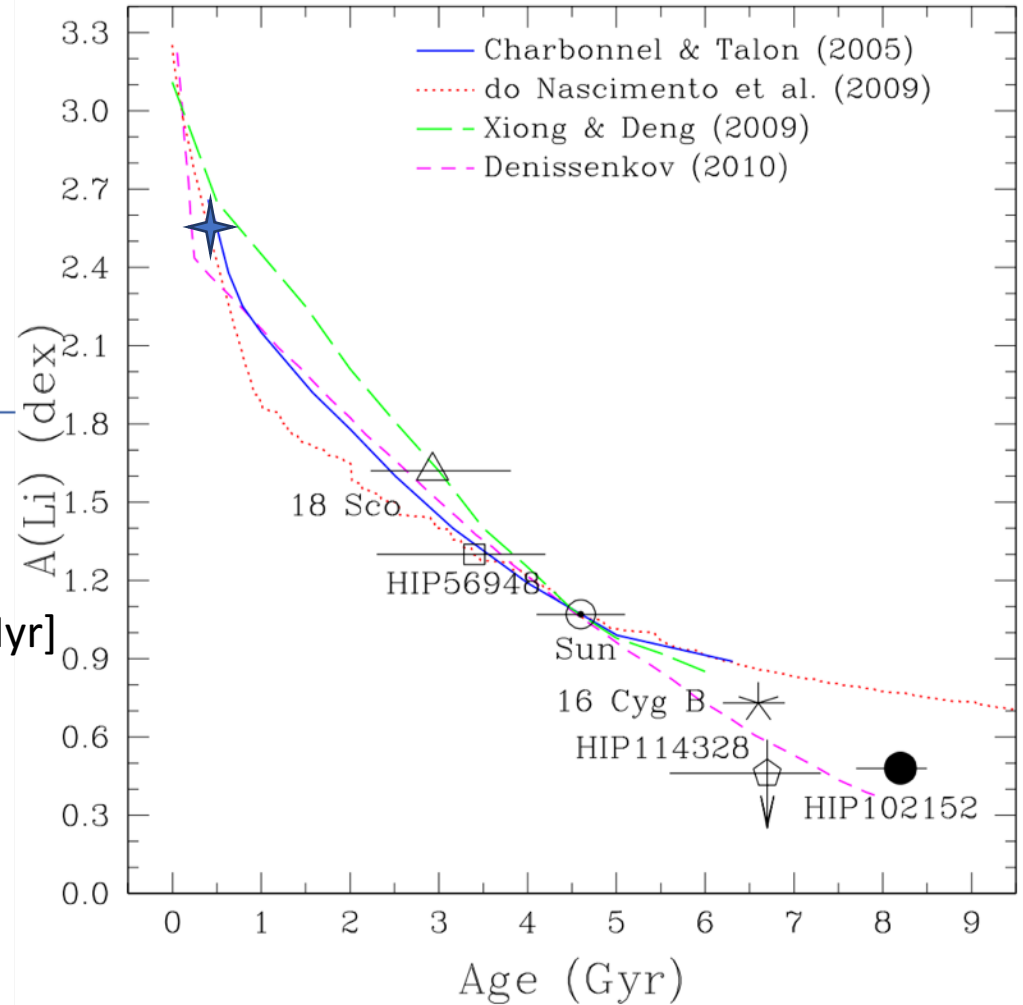
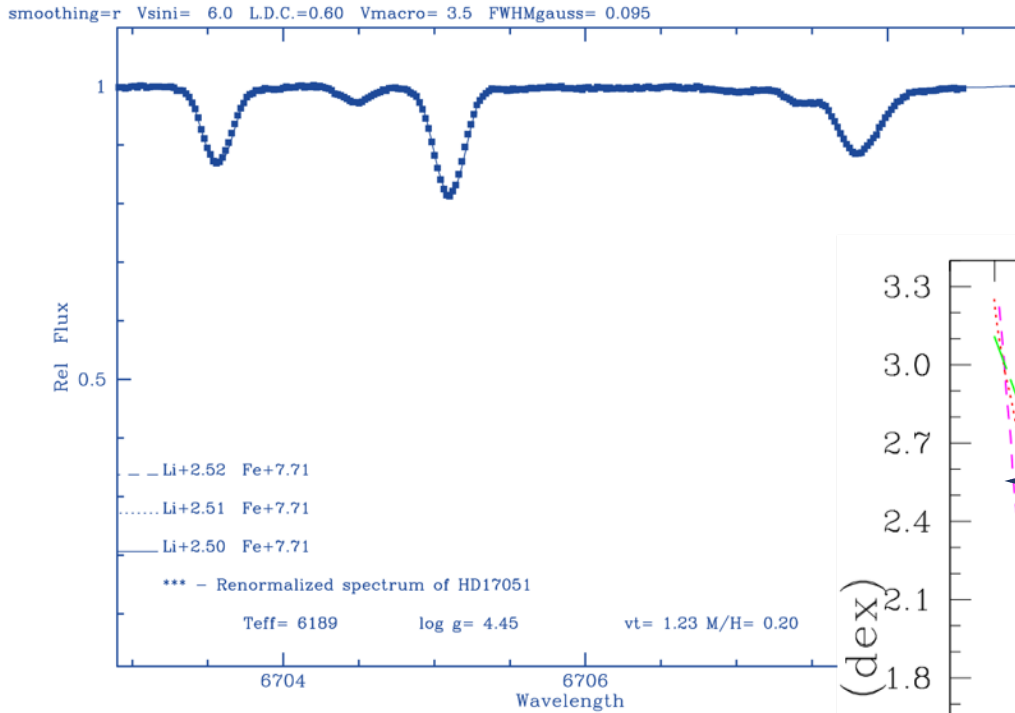


McQuillan et al. 2014

Prot = 7.42 [d] & Teff ~ 6189 [K] → Age < 1 Gyr

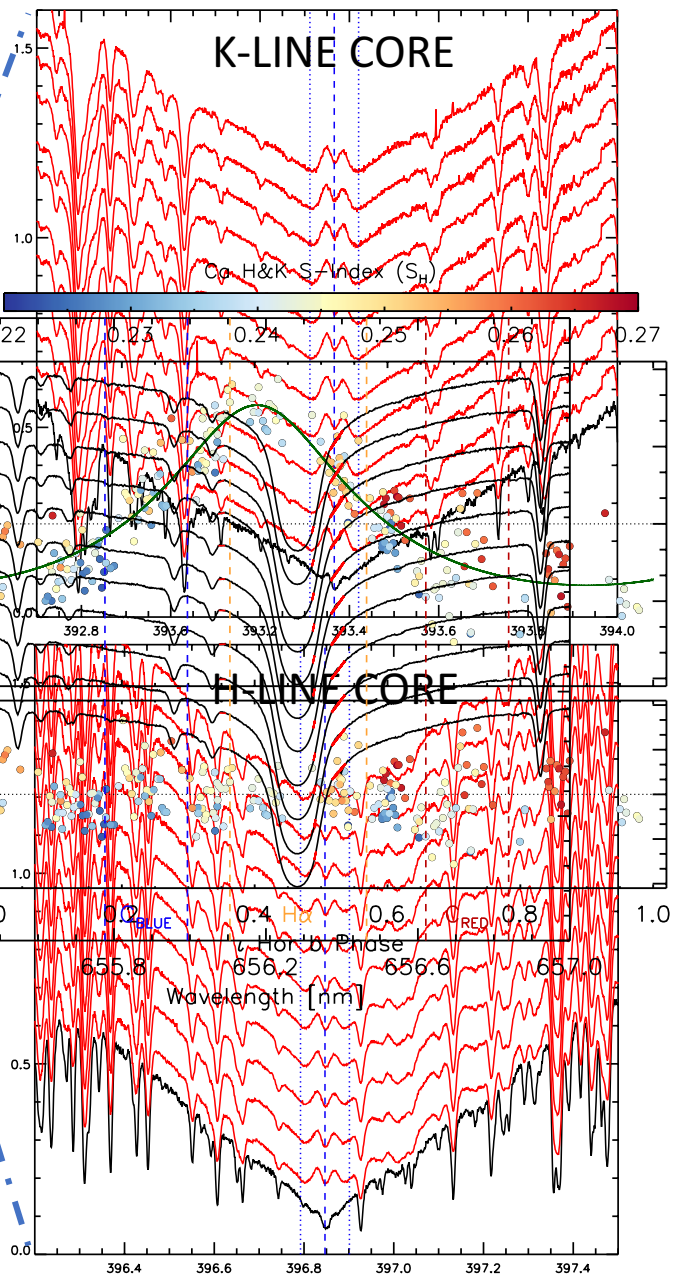
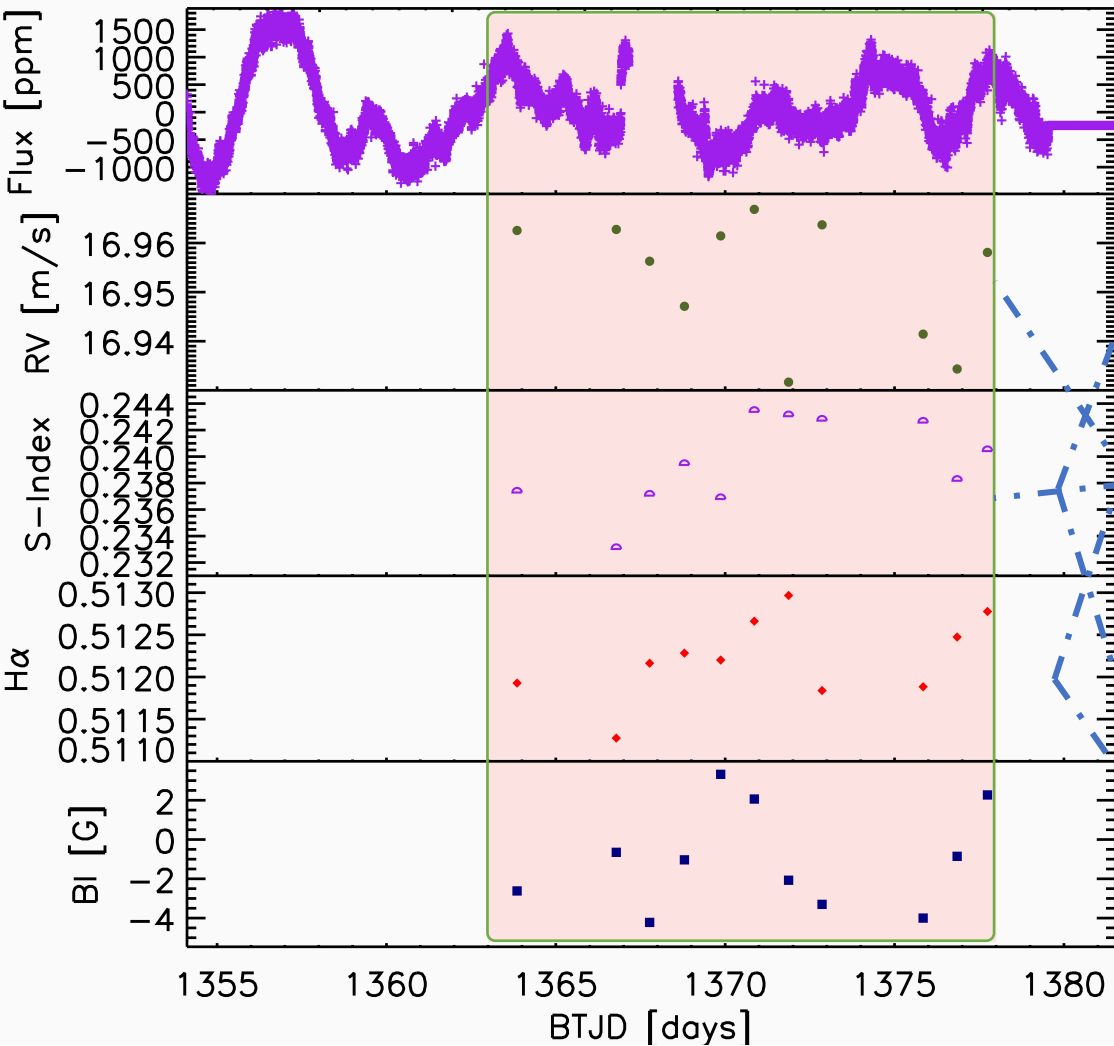
LITHIUM AGE-DATING

Melendez et al. 2013



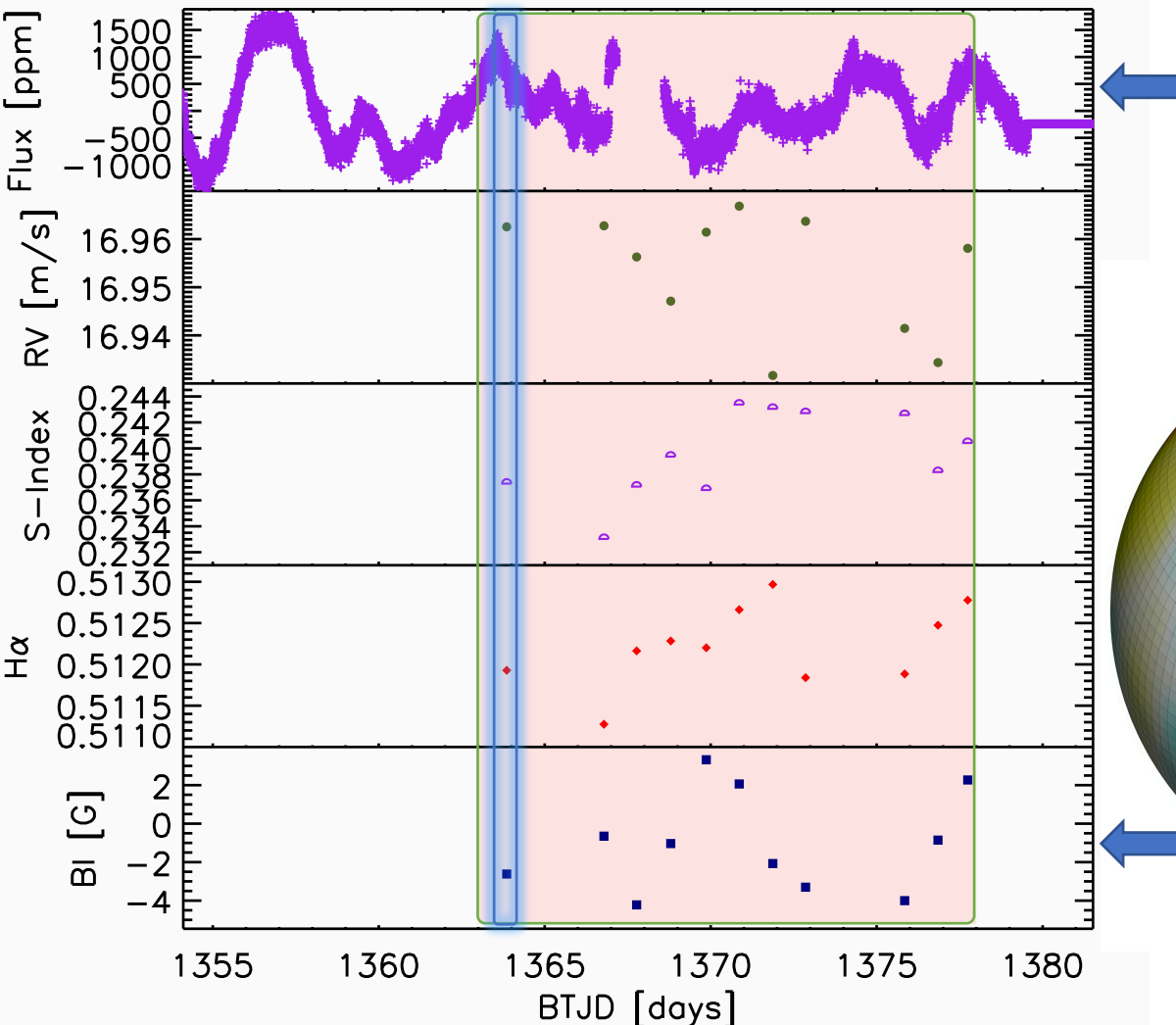
Lithium age-dating \rightarrow 600 - 1000 [Myr]
 Vsini fitting \rightarrow 6.0 [Km/s]
 Teff \rightarrow 6189 [K]
 Log g \rightarrow 4.45
 $\iota = 49^\circ \pm 8^\circ$

MULTI-TECHNIQUE FOLLOW UP

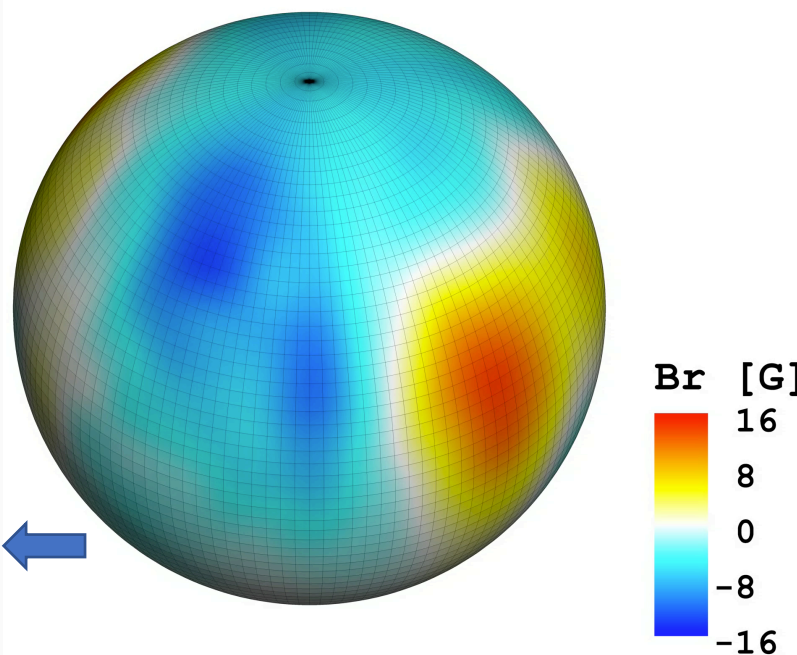


Amazo-Gómez + In prep.

MULTI-TECHNIQUE FOLLOW UP




Alvarado-Gómez + In prep.



Amazo-Gómez + In prep.

TO TAKE AWAY

- Comprehensive stellar analysis requires simultaneous multi-techniques, multi-wavelength data.
- Valuable information to characterize magnetism and activity, helpful for dealing with stellar noise in exoplanetary hunting.
- GPS method works not just for the determination of stellar rotational periods, but also to interpret stellar surfaces → F/S ratio.
- Better understanding of the stars would allow more realistic exoplanet characterizations.

A large, bright orange and yellow sun or star dominates the upper two-thirds of the frame. The color transitions from a deep orange at the bottom to a bright yellow at the top. A small, dark, circular spot is visible on the right side of the sun's surface. The background is a dark, almost black, space.

"Somewhere, something incredible is waiting to be known ..."
C. Sagan

SATIRE model : Spectral And Total Irradiance REconstruction

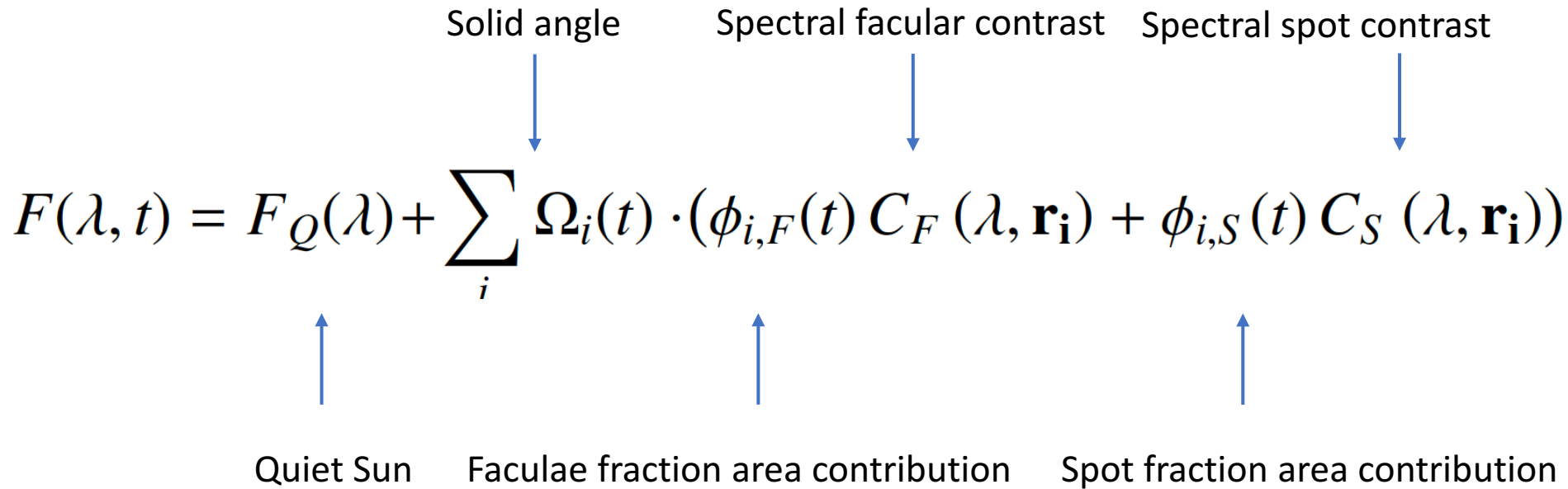
$$F(\lambda, t) = F_Q(\lambda) + \sum_i \Omega_i(t) \cdot (\phi_{i,F}(t) C_F(\lambda, \mathbf{r}_i) + \phi_{i,S}(t) C_S(\lambda, \mathbf{r}_i))$$


Diagram illustrating the components of the SATIRE model equation:

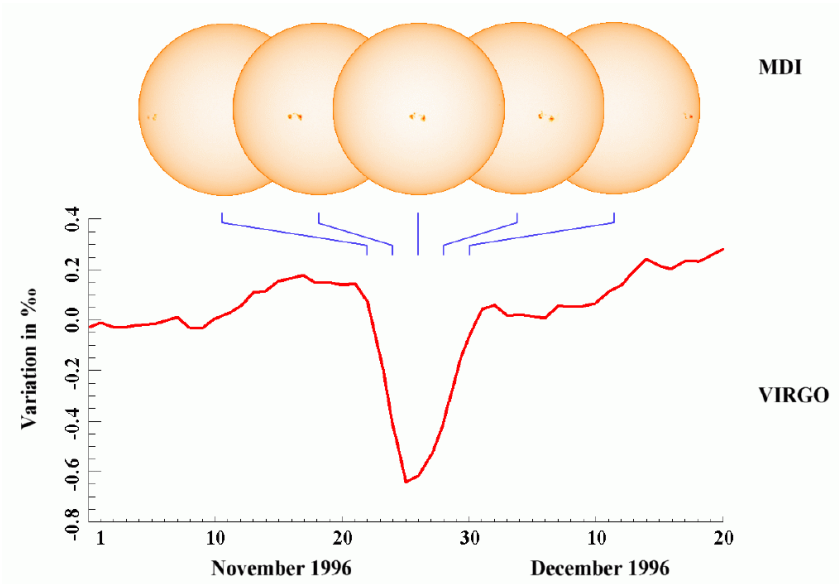
- $F_Q(\lambda)$ is associated with **Quiet Sun**.
- $\Omega_i(t)$ is associated with **Faculae fraction area contribution**.
- $\phi_{i,S}(t)$ is associated with **Spot fraction area contribution**.
- $\Omega_i(t)$ is associated with **Solid angle**.
- $C_F(\lambda, \mathbf{r}_i)$ is associated with **Spectral facular contrast**.
- $C_S(\lambda, \mathbf{r}_i)$ is associated with **Spectral spot contrast**.

i – i -th active region

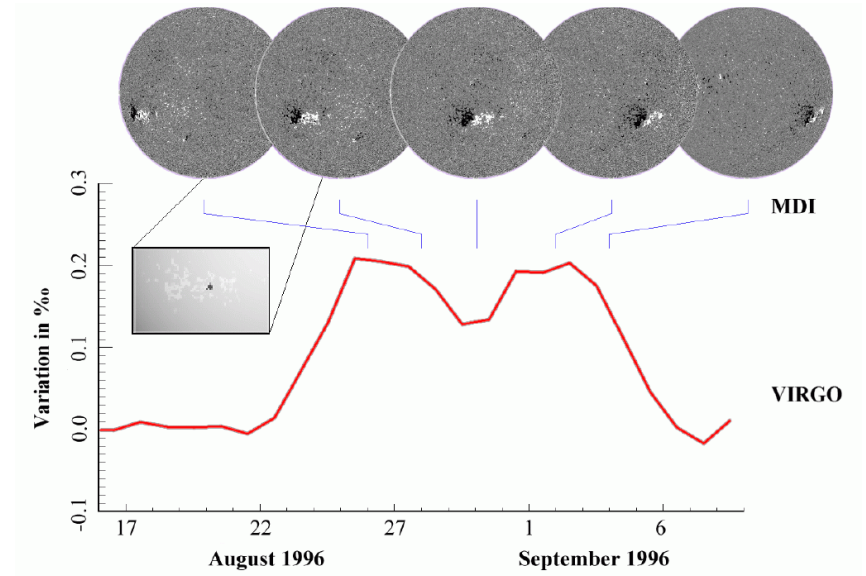
t – evolution time

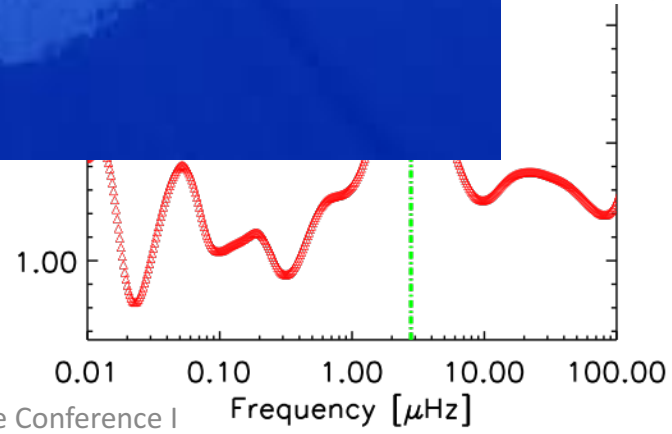
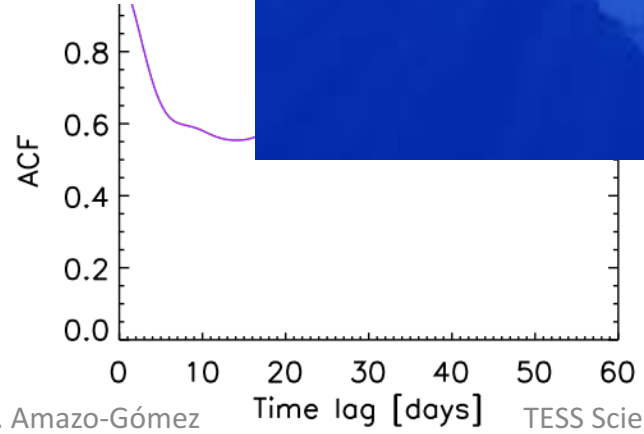
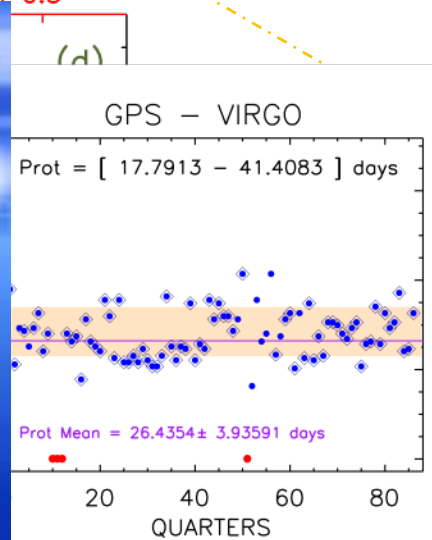
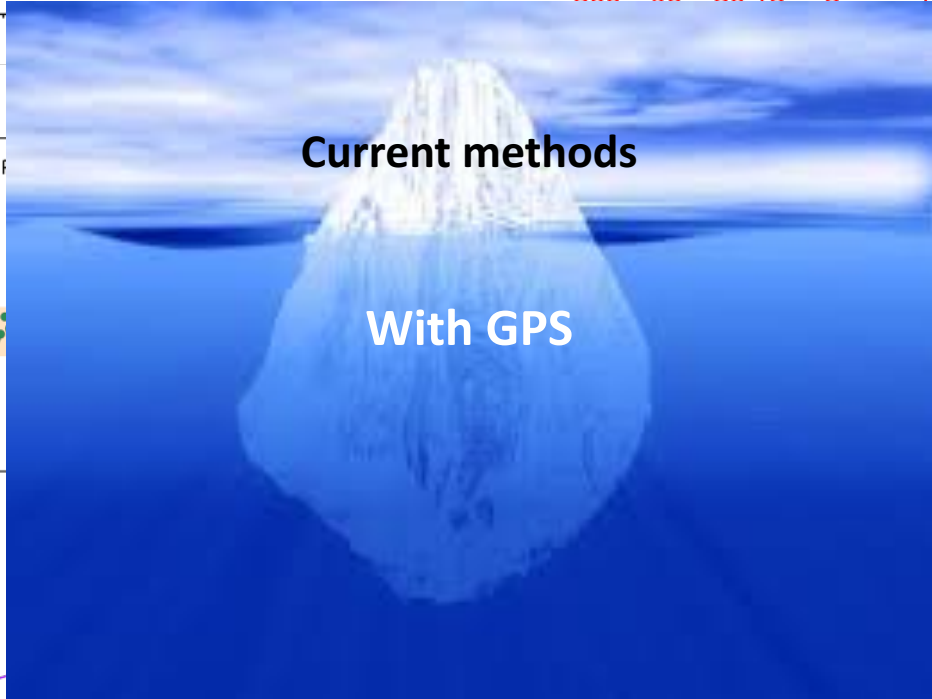
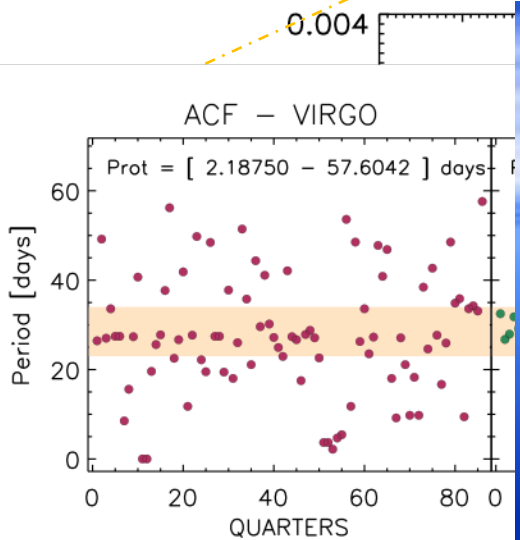
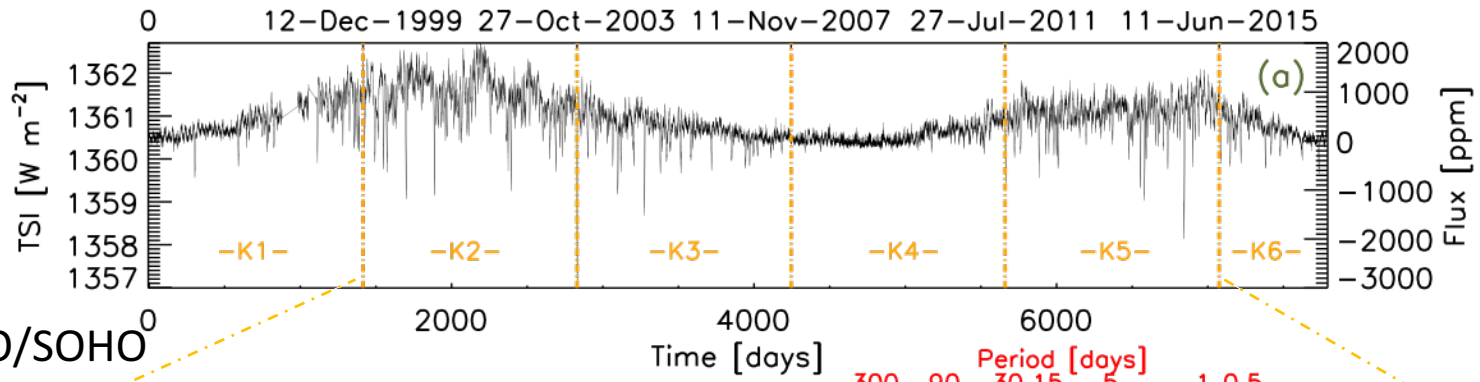
Transiting magnetic features imprint signatures in light curves

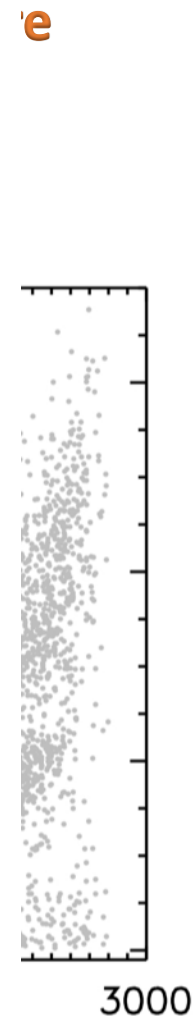
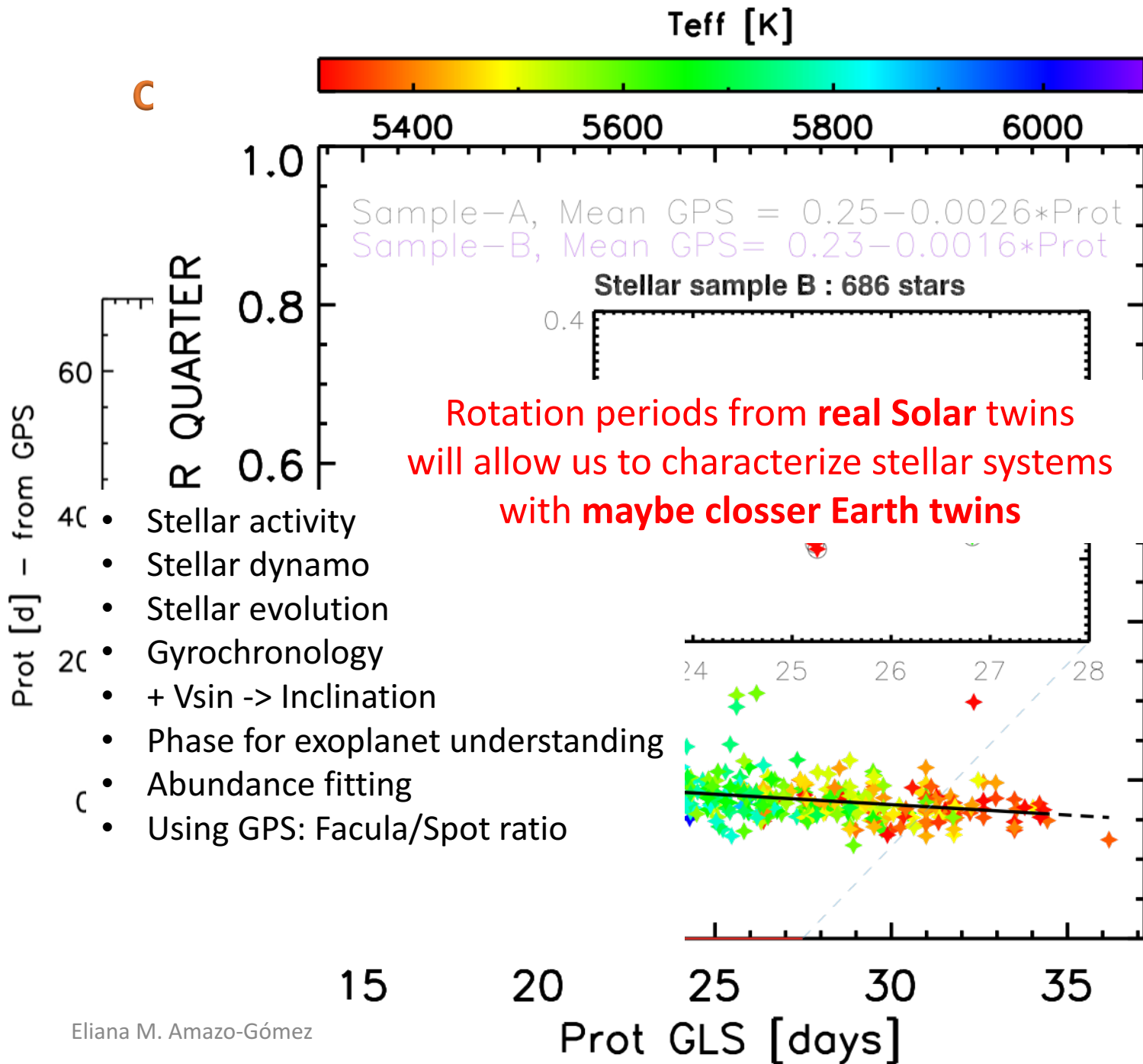
Spots



Facular region

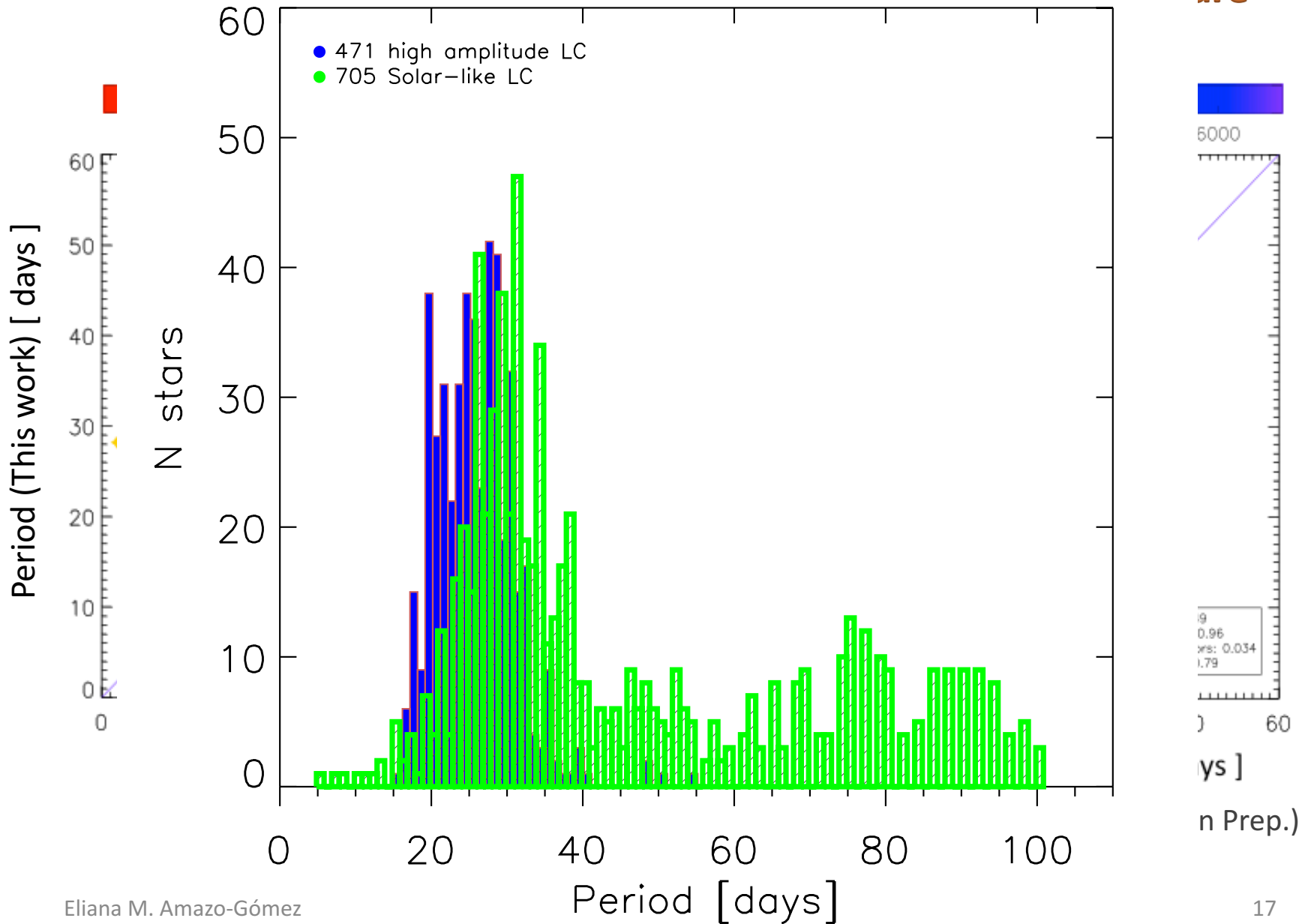


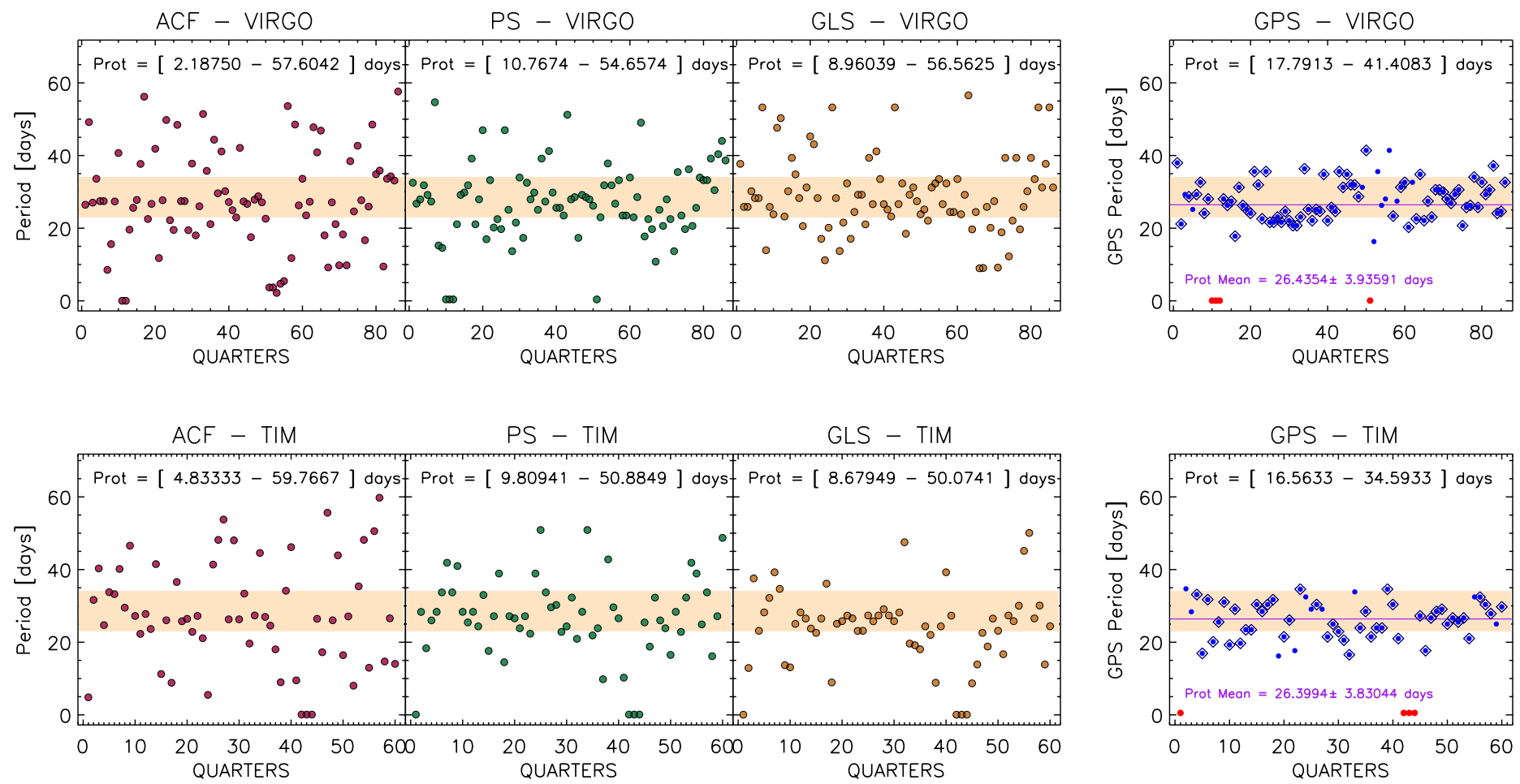




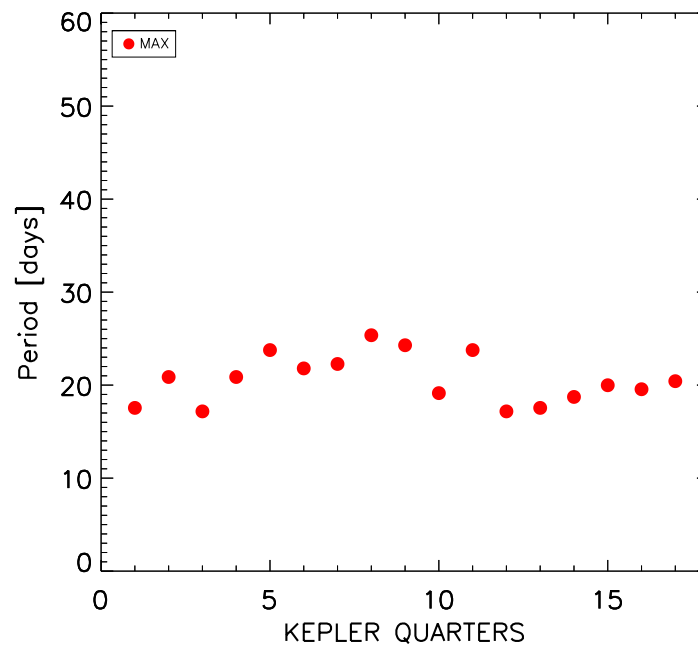
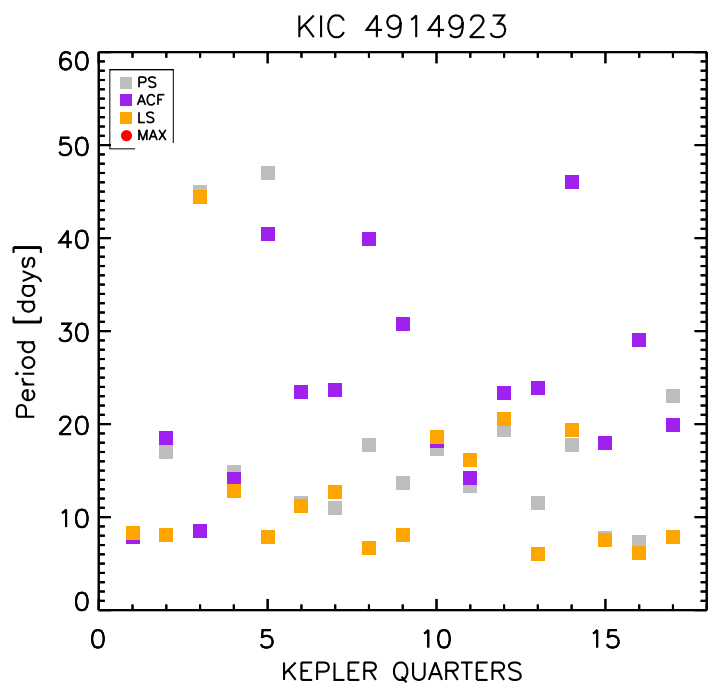
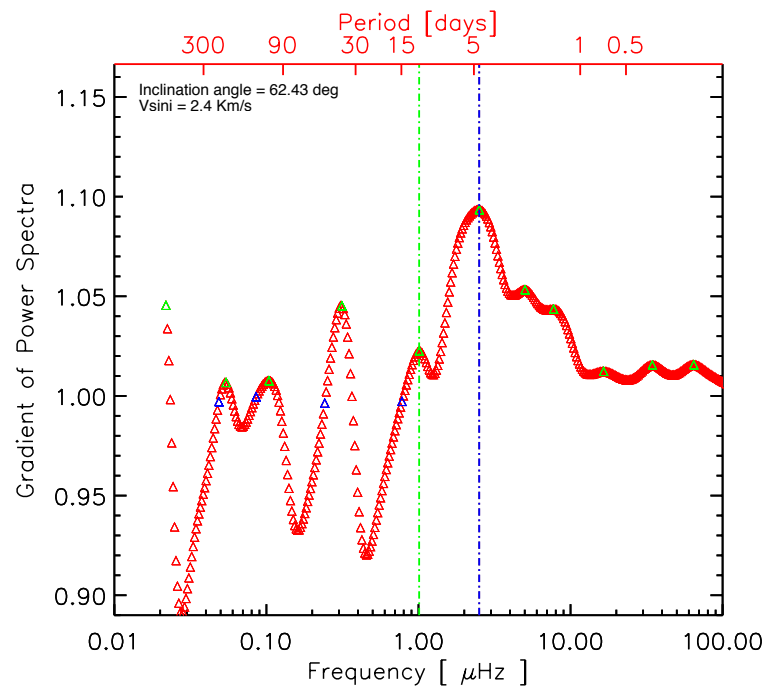
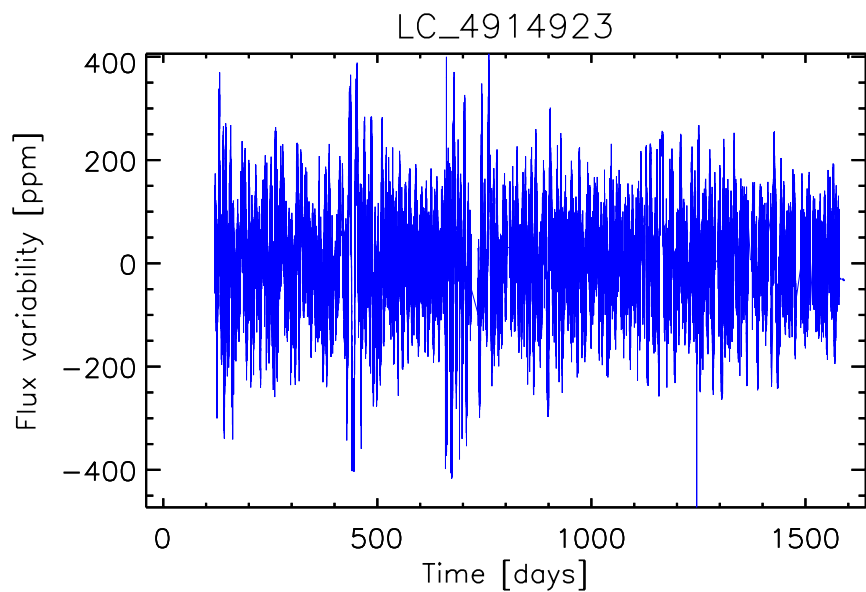
al. 2014

Prot distribution

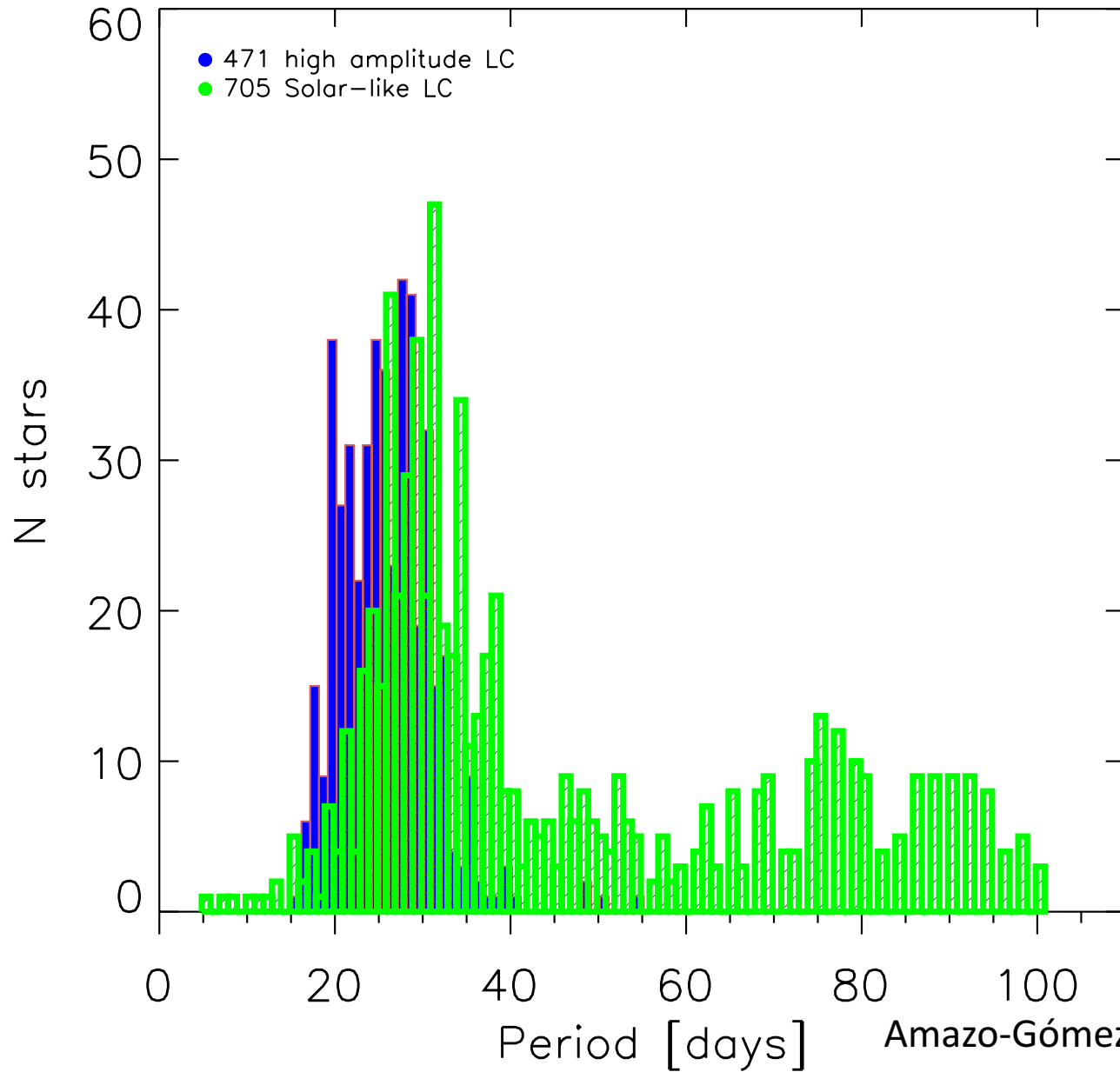




Amazo-Gómez et al. In prep



Prot distribution



Amazo-Gómez et al. In prep