



Flares and rotation periods of CARMENES M dwarfs from *TESS* data



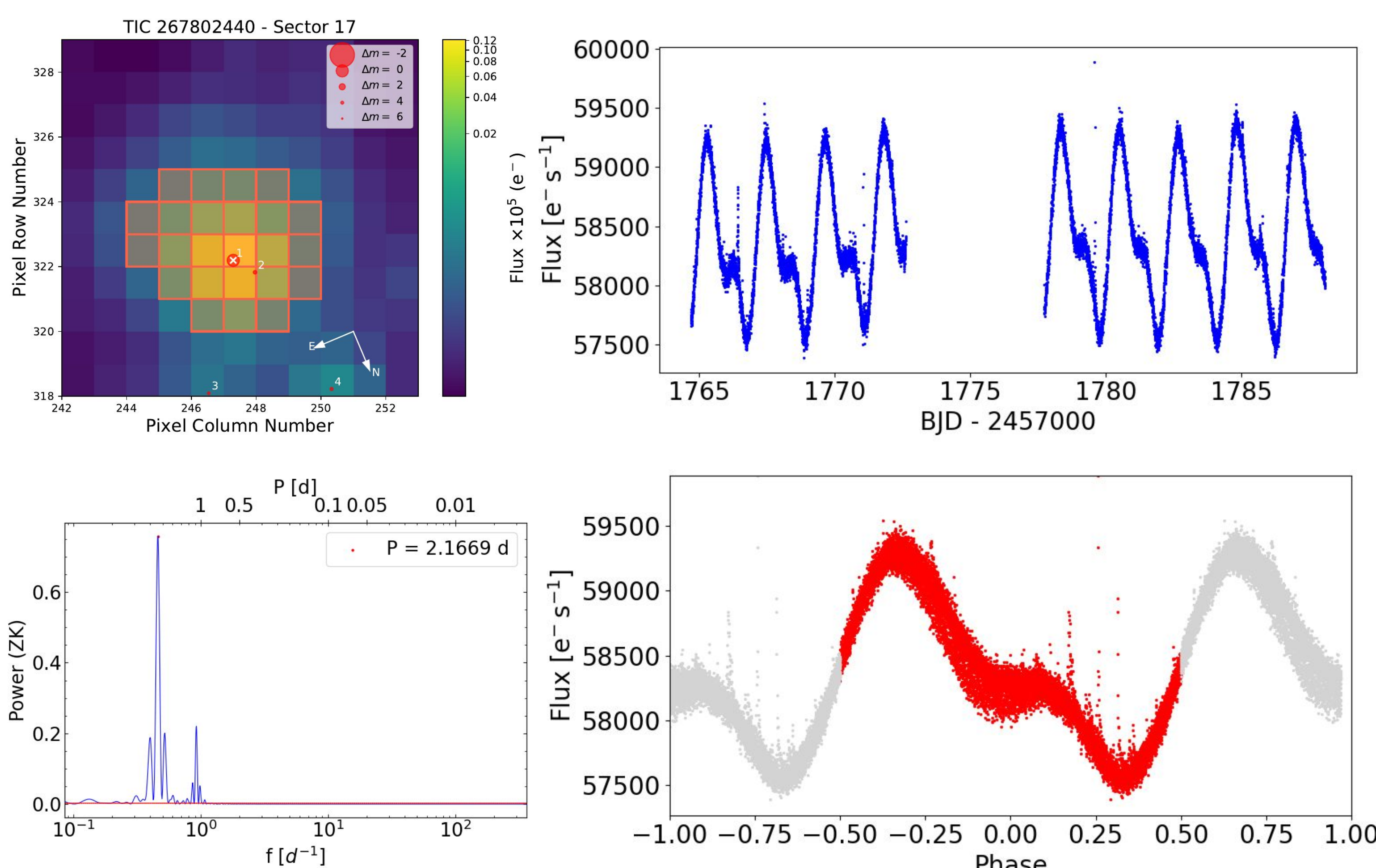
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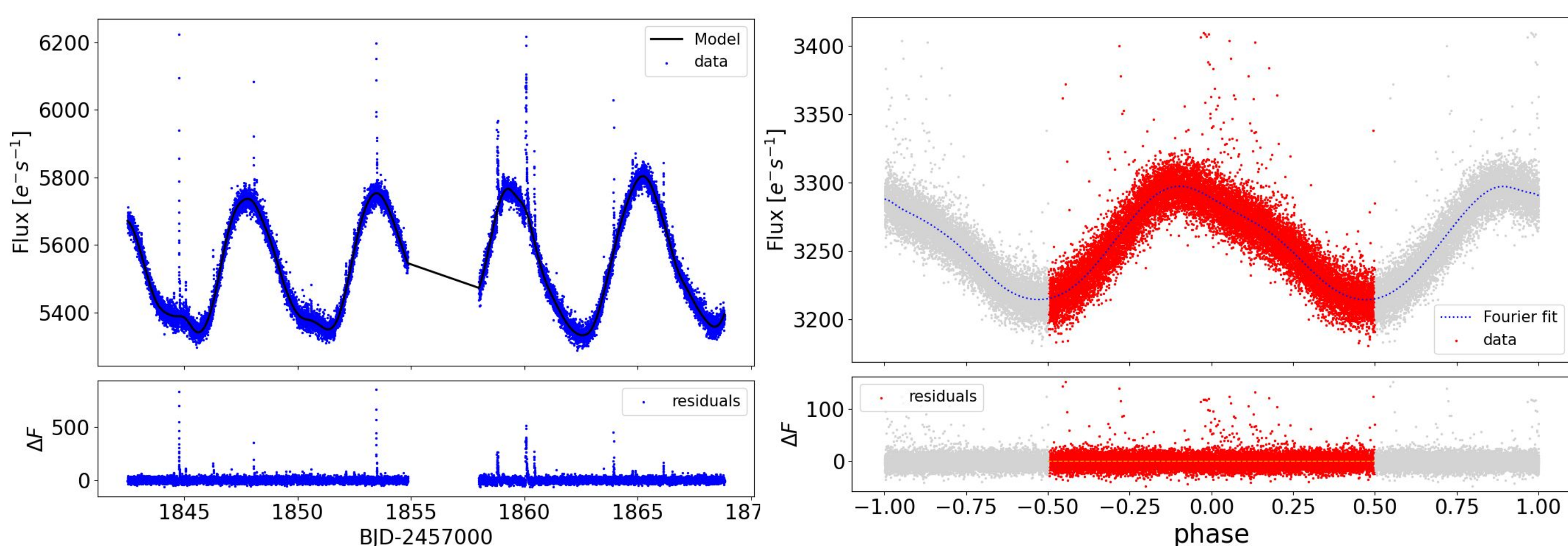
ABSTRACT: CARMENES is a spectrograph built for the 3.5 m telescope at the Calar Alto Observatory. The main aim is to detect low mass planets around M dwarfs. In order to achieve this goal, it is critical to characterize the monitored stars, especially their activity and rotation. Using Quick-Look Pipeline (QLP) *TESS* data from its first two cycles, we studied the rotation and activity in the 2-min cadence time series of 1249 M dwarfs in the CARMENES input catalog. Next, with Generalised Lomb-Scargle (GLS) periodograms, we measured 231 rotation periods between 0.11 d and 10.52 d. Of them, 147 are consistent with their literature counterparts and 74 were previously unknown. Using splines and Fourier polynomials, we detrended the light curves of the stars for which we found a rotational period in order to look for flaring activity. We measured energies between 10^{30} erg and 10^{35} erg of 1922 flares of 225 periodic M dwarfs. We fitted the cumulative frequency distribution of flares with energies greater than 10^{33} erg to a power law of the form $NdE \propto E^{-\alpha}dE$ and determined $\alpha = 2.119^{+0.075}_{-0.105}$. We also found α to increase for later spectral types.

METHODS

Karmn J00428+355 = FF And

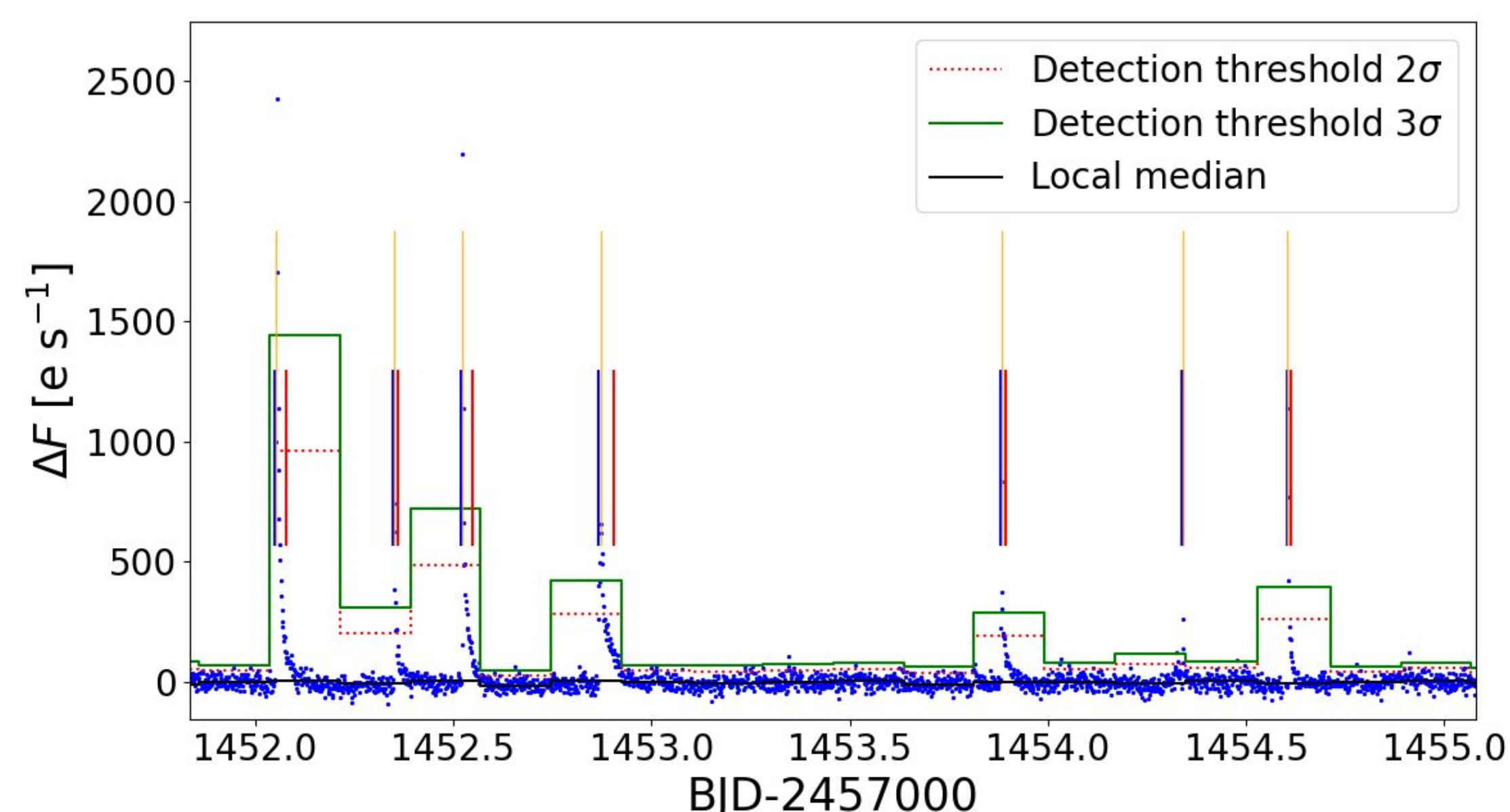


▲ The top left panel represents the aperture mask drawn with *tpfplotter* and was used to determine the fraction of light from each star in the Target Pixel File (TPF). The top right panel shows the QLP light curve for which we obtained the GLS periodogram (bottom left) to determine the rotation period. The light curve was phase-folded using the highest peak from the GLS (bottom right) in order to examine the plausibility of the obtained period.



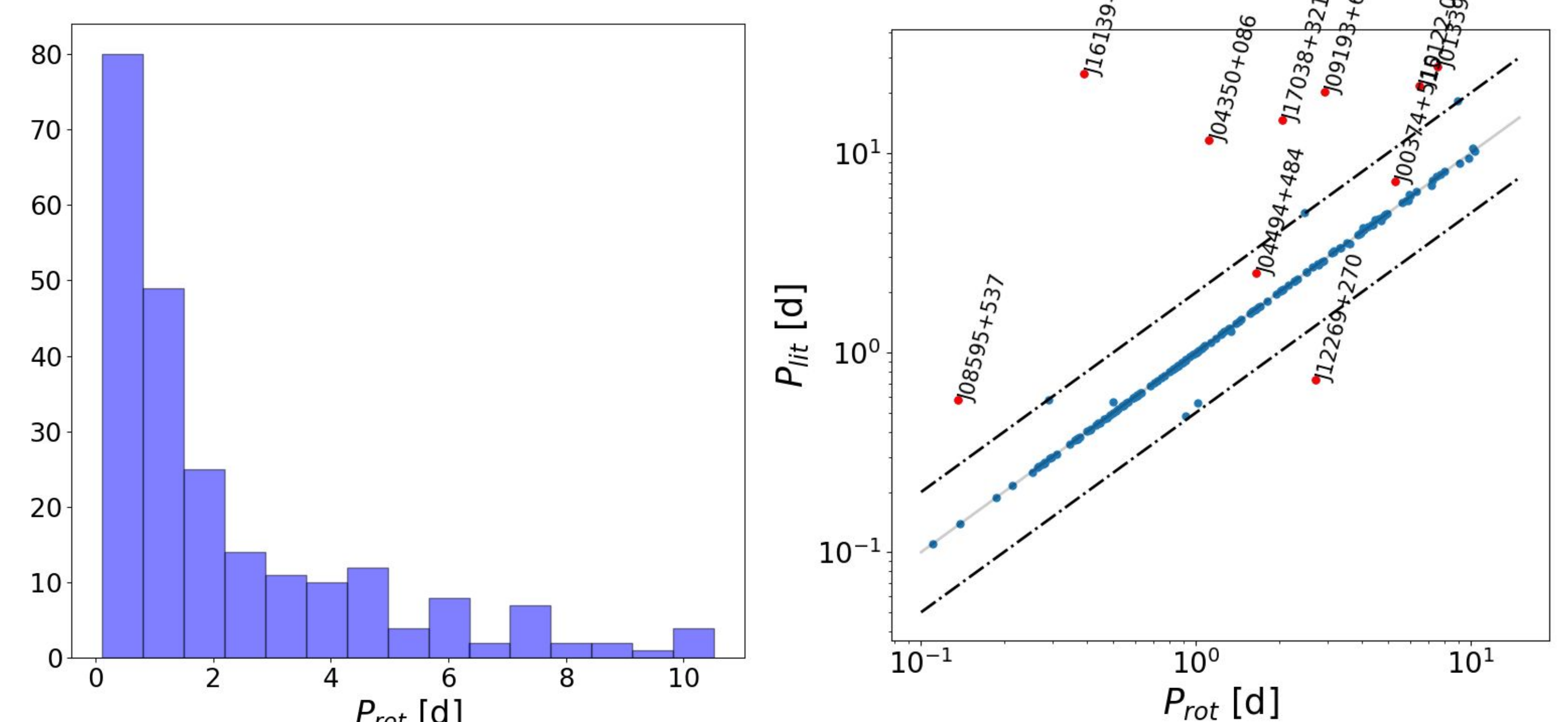
▲ The light curves were detrended using splines (left) or by fitting a Fourier polynomial to the phase folded light curve if the rotation period was of the order of the duration of a flare (right).

Karmn J03473-019 = G 80-021



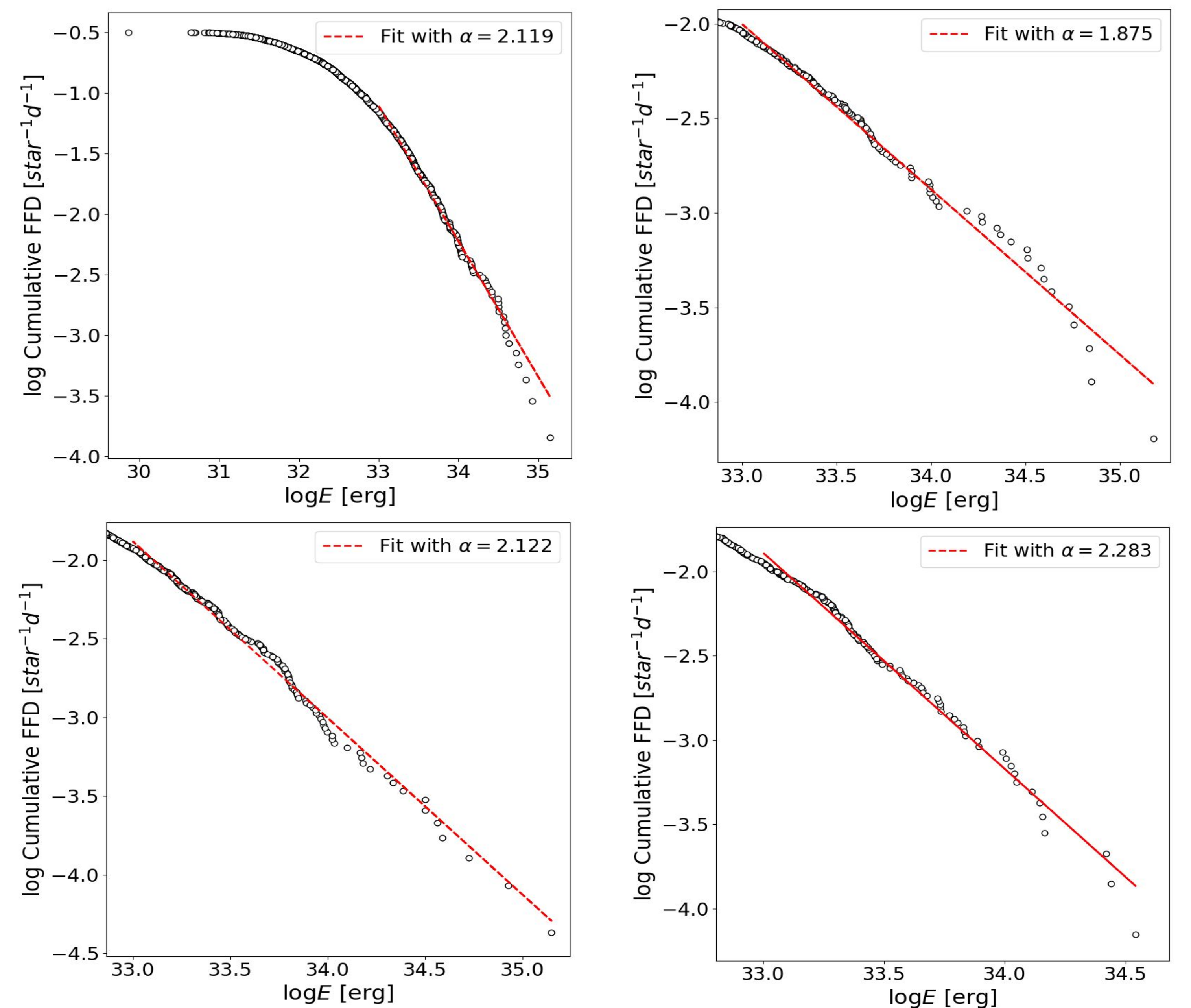
▲ A search for flares was performed on the detrended light curves of 161 single stars using sigma clipping over a 128 point median. The beginning (blue vertical lines) and ending (red vertical lines) points were determined using the distribution of the residual flux variation. Flare energies were calculated by modeling flares as a black body at 9000 K.

RESULTS



▲ 231 periods between 0.11 d and 10.52 d were measured using *TESS* QLP data. 74 periods are reported for the first time. Most of the measured periods (63%) are shorter than 2 d.

▲ Measured periods (x-axis) compared to what was found in the literature. The dashed lines represent the 1:2 and 2:1 relations. 10 of the measured periods are not consistent with their literature counterparts (red points).



▲ We find 2215 flares with energies in the range $7.4 \cdot 10^{29}$ - $1.4 \cdot 10^{35}$ erg. The cumulative distribution is truncated for energies $< 10^{33}$ erg due to data noise and the search algorithm. Fitting the distribution for energies $> 10^{33}$ erg to a power law of the form $NdE \propto E^{-\alpha}dE$, we find α to be $2.119^{+0.075}_{-0.105}$ (top left). Separating stars into spectral types, we find $\alpha = 1.875^{+0.041}_{-0.060}$ for M0 V to M2 V (top right), $\alpha = 2.122^{+0.070}_{-0.103}$ M2 V to M4 V (bottom left) and $\alpha = 2.287^{+0.060}_{-0.141}$ for M4 V to M6 V (bottom right).

Acknowledgements

This work made use of the GLS periodogram developed by M. Zechmeister (<https://github.com/mzechmeister/GLS>) and the *tpfplotter* program developed by J. Lillo (<https://github.com/jlillo/tpfplotter>). The work presented in this poster was possible thanks to the concession granted by the Instituto de Física de Partículas y del Cosmos (IPARCOS-UCM, <https://www.ucm.es/iparcos/>).

