Flares on solar-type stars

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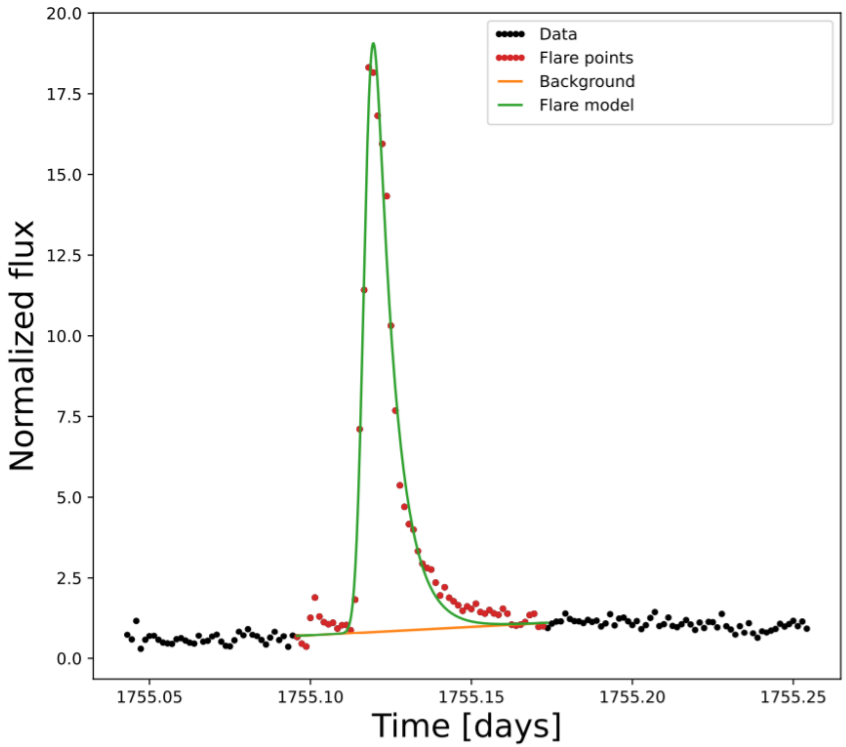
Flares on solar-type stars

- Stellar flares are highly energetic, rapid events, occur during magnetic reconnection in the stellar corona
- Research of stellar flares from nearby stars have been rapidly developing in recent years thanks to big optical photometric surveys (Kepler, TESS)
- Studies for solar-type stars have shown the occurrence of superflares with much greater energies than the largest solar flares
- The appearance of super-flare in the Sun can lead to a geomagnetic storm and wide spread blackout



Research questions

- How many flaring, solar-type stars are observing TESS?
- How frequent are flares on solar-type stars?
- What are the basic flare parameters (amplitude, duration)?
- What are the flare energies?

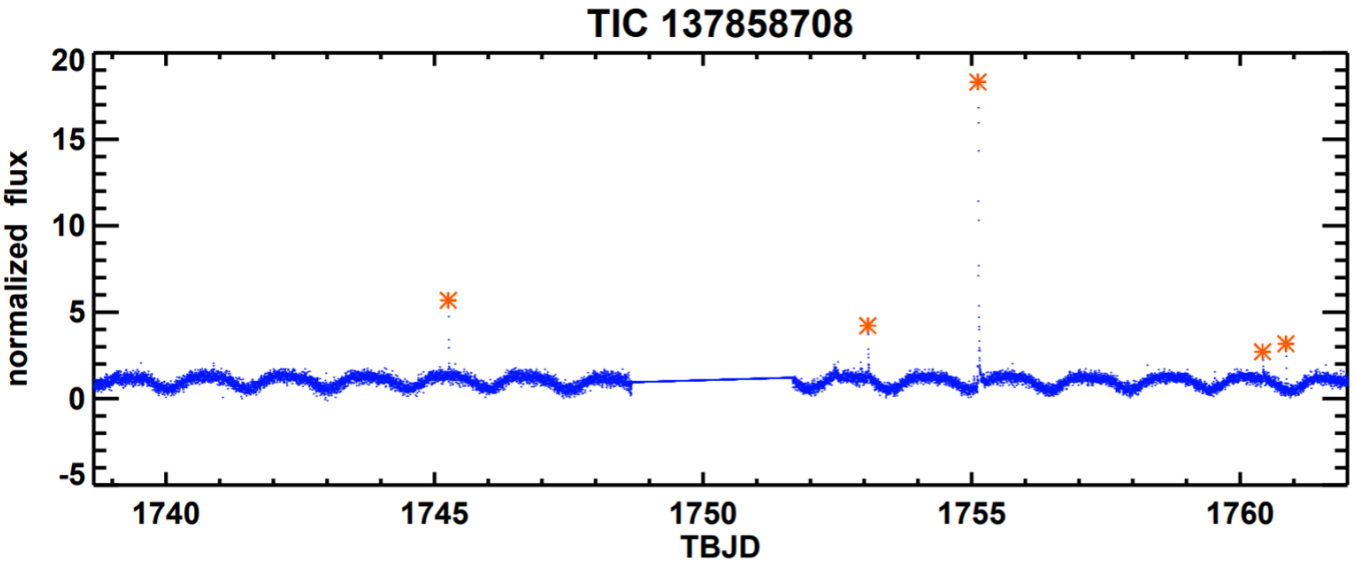
Data

- TESS (*The Transiting Exoplanet Survey Satellite*), a space-based telescope launched in July 2018
- TESS uses a red-optical bandpass (600 to 1000 nm)
- For now we have analyzed 37 sectors (about 300000 stars)
- We used two-minutes data
- We use effective temperature T_{eff} and surface gravity $log(g)$ as criteria to select solar-type stars
- We obtain stellar parameters from MAST and SIMBAD databases

Methods of flare detections

WARPFINDER (Wroclaw AlgoRithm Prepared For detectINg anD analysing stEllar flaRes) - an automated, three step software

1. The trend method: de-trending of the light curves, determine the standard deviation and check which data points are above the assumed sigma level
2. The difference method: checking the flux difference between two consecutive points and examining the standard deviation
3. The profile method: fit the assumed flare profiles to the data and check the chi-square statistic



Flare energies

Our software estimates the energy of flares in two different methods:

1. We assume black body radiation and effective temperature of a flare about 10000 K (Shibayama et al. (2013))
2. We calculate flux of the star using the spectrum of star taken from ATLAS9 (Castelli & Kurucz (2003)) (Kovari et al. (2007))

The energies of stellar flares ranges from 10^{31} to 10^{36} erg. The method using the spectrum of star usually gives higher energy estimation.

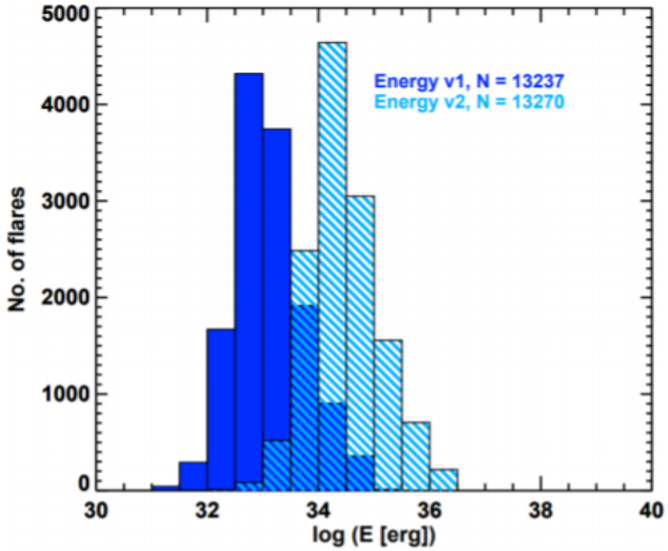


Figure 3: The distribution of flare energies for 3292 solar-type stars from S01-S37 estimated using methods based on Shibayama et al. (2013) (v1, dark blue) and based on Kovari et al. (2007) (v2, light blue).

Results and conclusions

- We identified about 13000 flares from more than 3000 solar-type stars
- The star with the biggest number of detected flares (402) is TIC 364588501 (HD 39150) observed in 23 sectors
- The most of amplitudes do not exceed the value of 0.2 of the normalized flux with subtracted background
- The duration of a stellar flares ranges from a few minutes to several hours

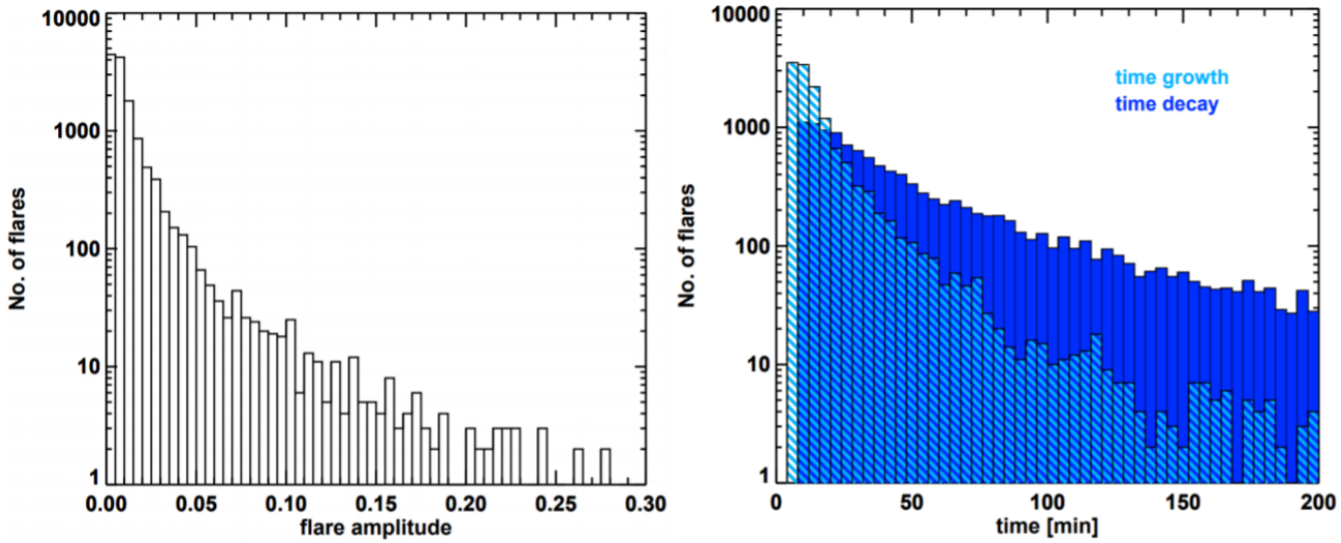


Figure 1: The distributions of the basic parameters of stellar flares: amplitude $(left)$, growth and decay times $(right)$.

Thank you for attention

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