ARCHITECTURE OF PLANETARY SYSTEMS AND THEIR EFFECT ON THE OCCURRENCE OF STELLAR FLARES

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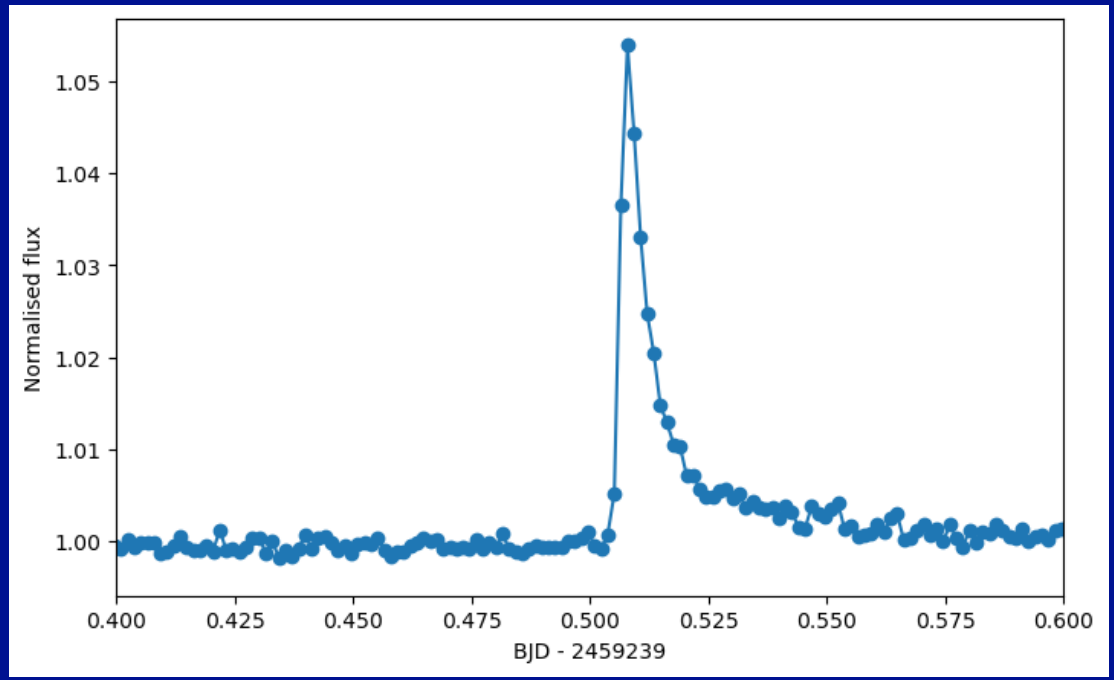
Introduction and motivation

- Stellar flares are bursts of electromagnetic radiation due to the reconnection of the star's magnetic field
- Observed stellar flares $10^{28} - 10^{38}$ ergs
- Duration – minutes
- Sun's magnetic cycle and Jupiter's orbital period suspiciously similar
- Aim to determine whether there is a correlation between the architecture of planetary systems and the occurrences of stellar flares



Methodology

- Obtain data from Kepler and TESS satellites
- Identify flaring stars that have planets
- Find out whether flares occur periodically
- Use Kepler orbital elements and try to match to the periodicity of flares

Data collection

Flare catalogues

- Immediately available
- Limited to the authors' choices
- Kepler catalogue (Althukair, 2023+)
- TESS catalogue (Seli, 2025+)

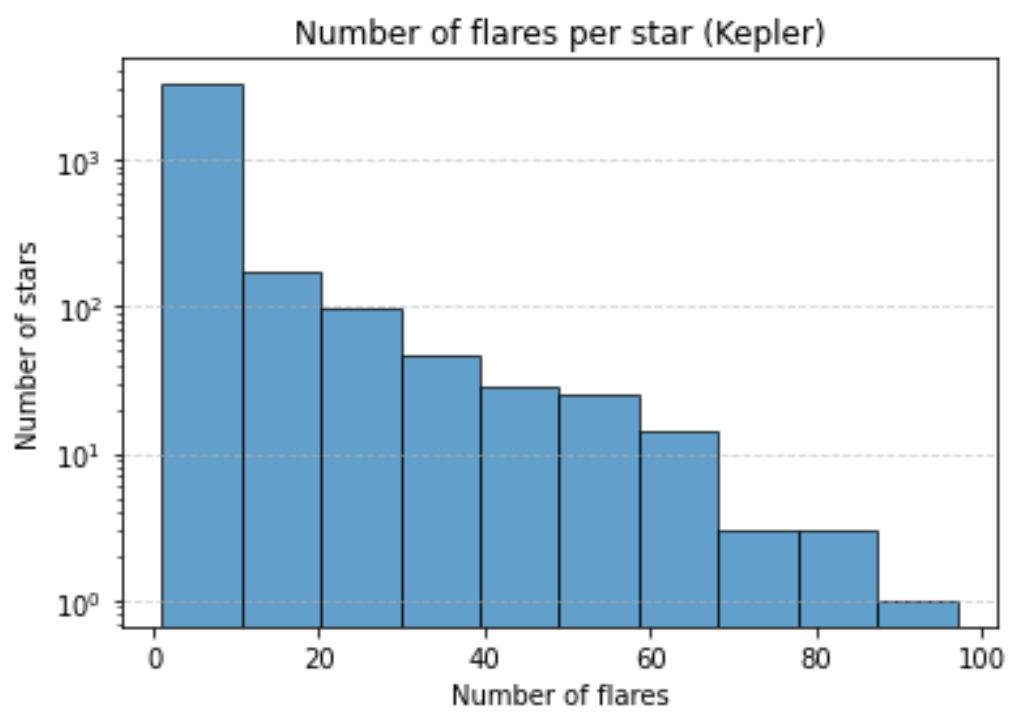
Exoplanet archive

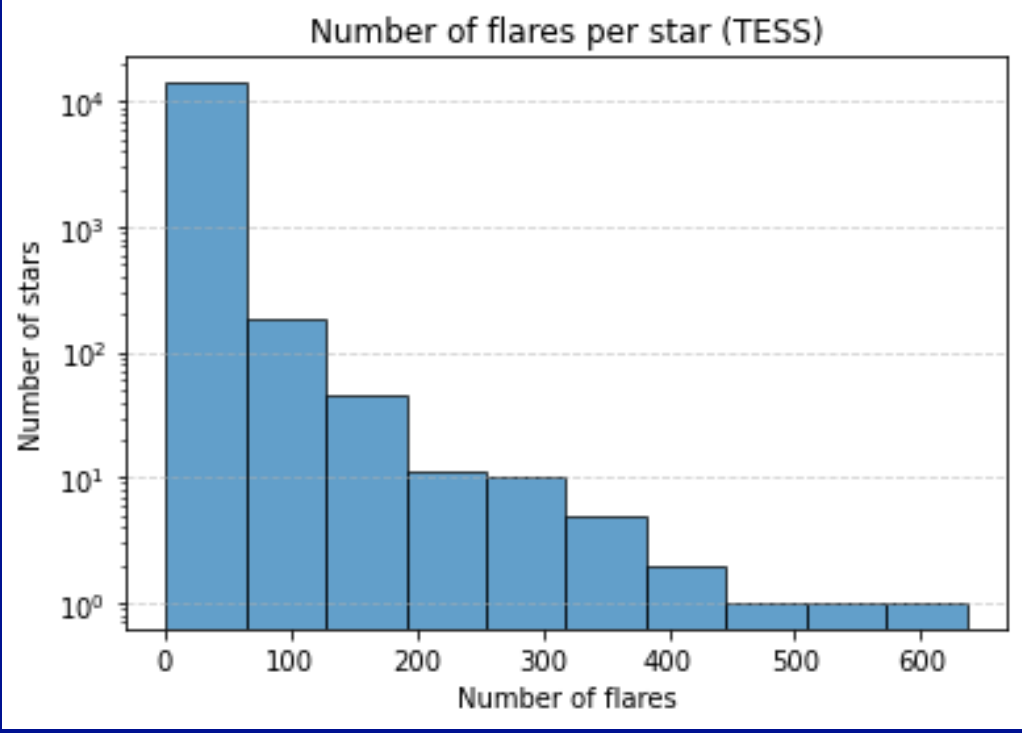
- Less observation bias
- More recent data (light curves and exoplanets)
- Will have to search for flares manually

METHOD 1 – FLARE CATALOGUES

Filtration

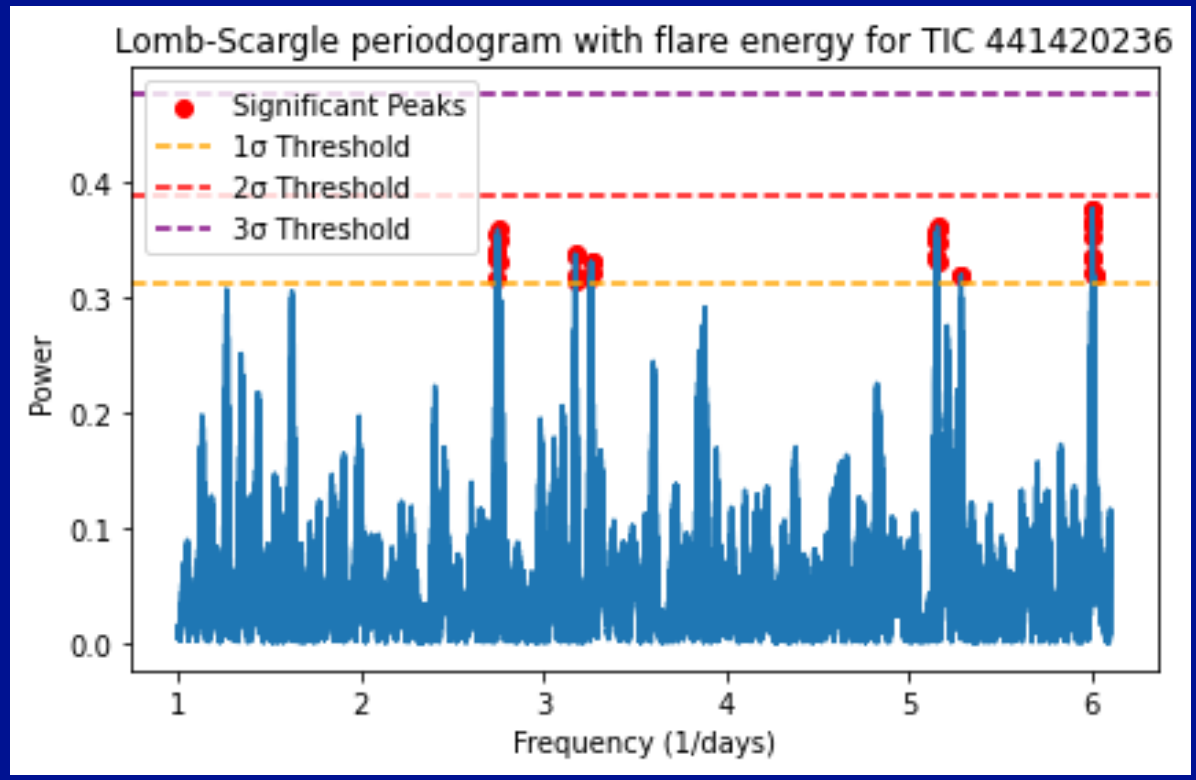
- Only stars with > 30 flares measured examined further
  - Kepler – 117 stars
  - TESS – 834 stars





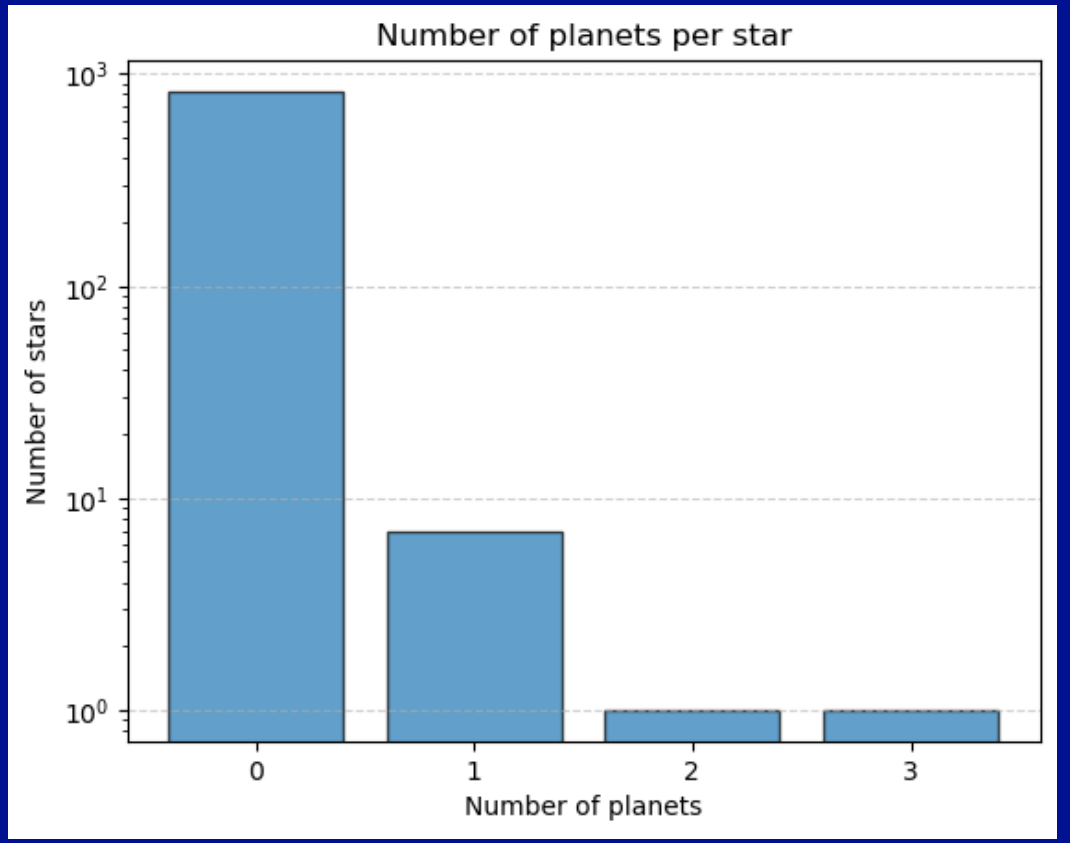
Lomb-Scargle periodograms

- Identify if flares are periodic
- Looking for at least 1 sigma (using false alarm probability)
- Kepler – 58 stars
- TESS – 266 stars, out of which 2 have planets



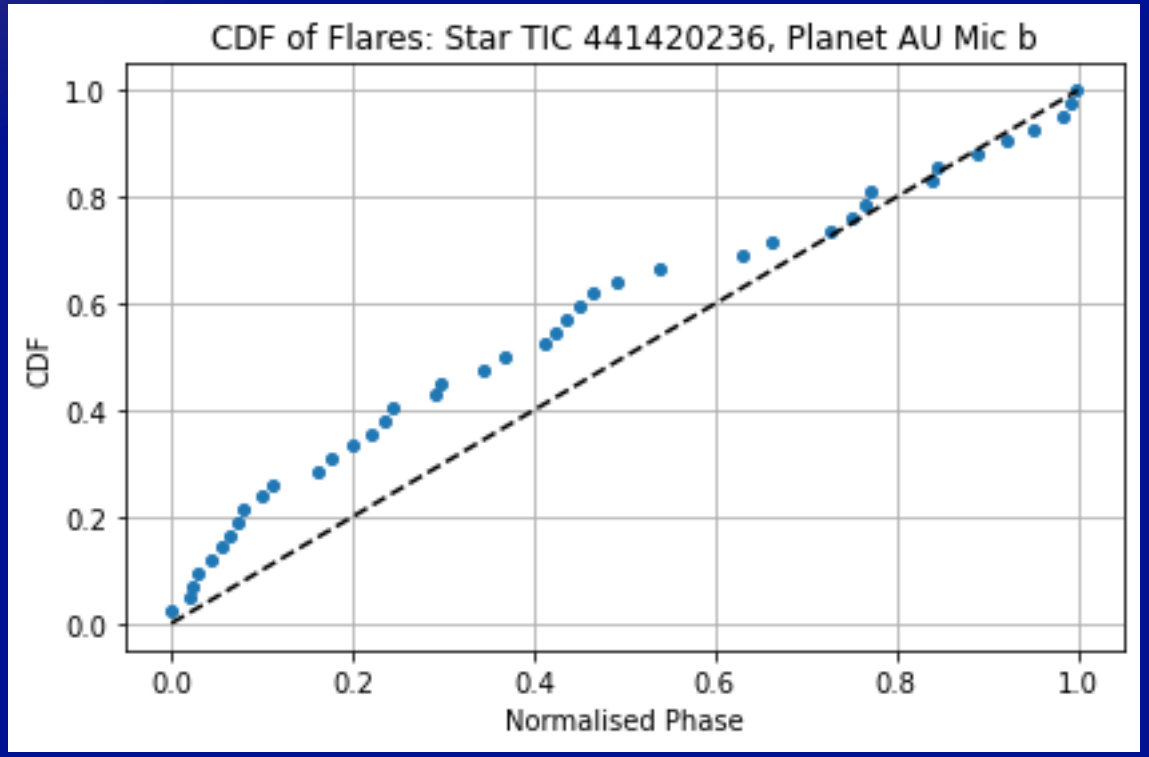
Exoplanet search

- NASA exoplanet archive
- Kepler (117 stars):
  - No known exoplanets
- TESS (834 stars):
  - 9 stars have exoplanets
  - 12 exoplanets in total



CDF

- Shows the distribution of flares based on exoplanet's orbital period
- 8/12 planets have known orbital periods
- No correlation – 45 degrees



METHOD 2 – EXOPLANET ARCHIVE

Filtration

4403 stars with planets

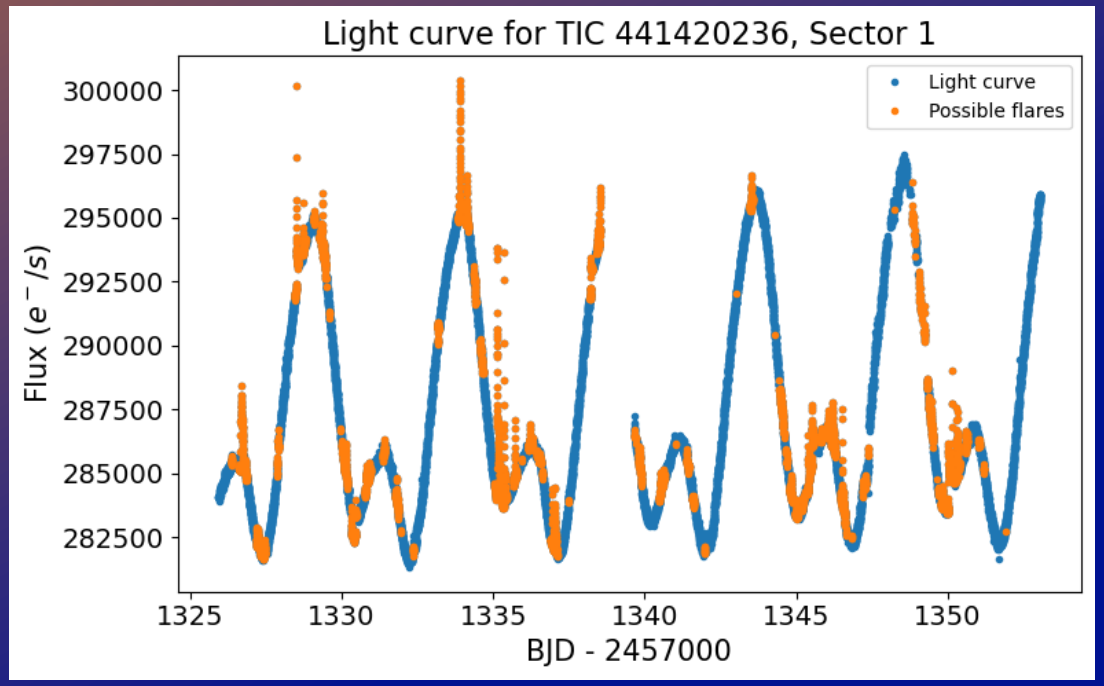
4054 stars with planets (with periods no longer than 10 years)

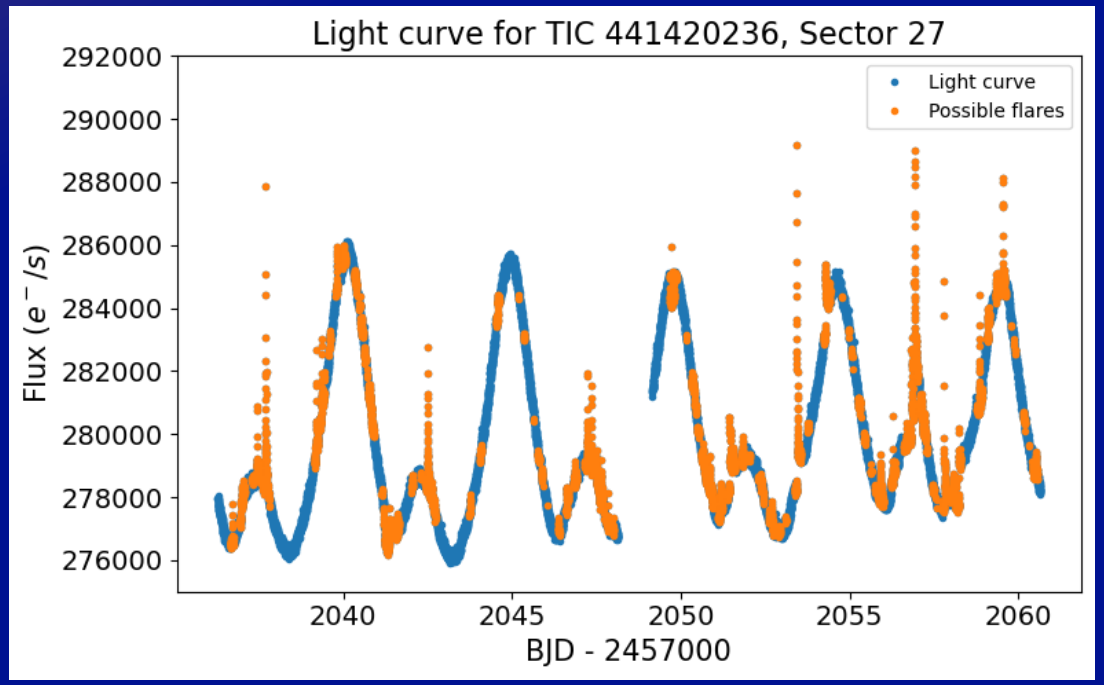
4035 stars measured by TESS

3699 stars with already reduced light curves

Flare detection

- flatwrm2 (Seli, 2025+) – deep learning code
- Predicts when flares occur
- Trained on TESS 2-min cadence data
- Tested for a few stars





Continuation

- Analyse all light curves using flatwrm2
- Kolmogorov-Smirnov test to see if CDF significant
- Construct shape of exoplanet orbit using orbital elements and compare with CDF
- Revisit filtered out planets/stars (could be updated in the case of planets or could try light curves from Kepler)

THANK YOU FOR YOUR ATTENTION