



Universiteit  
Leiden  
Sterrewacht Leiden

# The Leiden/ESA Astrophysics Program for Summer Students (LEAPS) 2022



## The search for Quasi-Periodic Pulsations (QPPs) in stellar flares using TESS data

Under supervision of:

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Solar flares, oscillations, QPPs
2. **Maximilian N. Guenther**, European Space Agency (ESA) Fellow  
Exoplanets, solar flares, and habitability

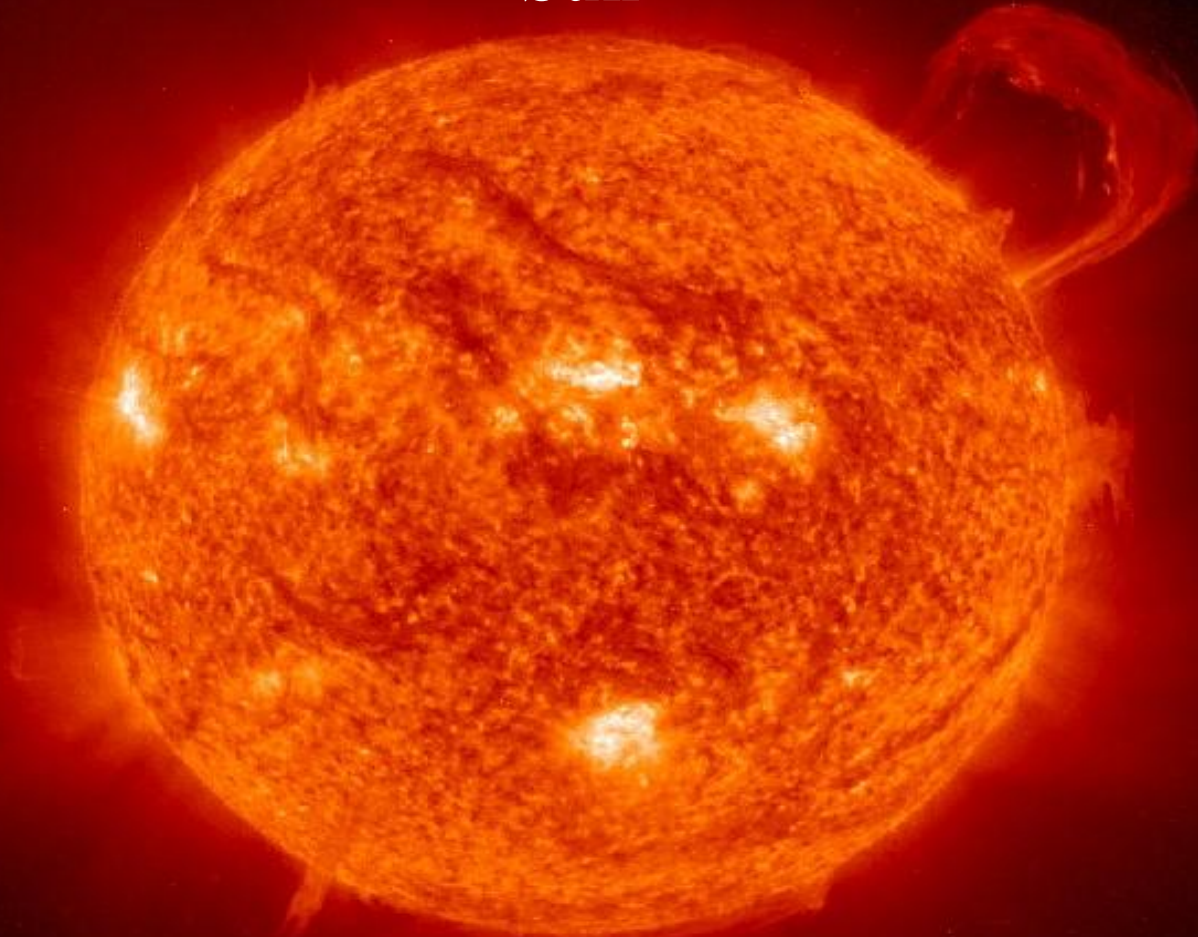
By:

**Prachi Rahate**

University of Potsdam, Germany

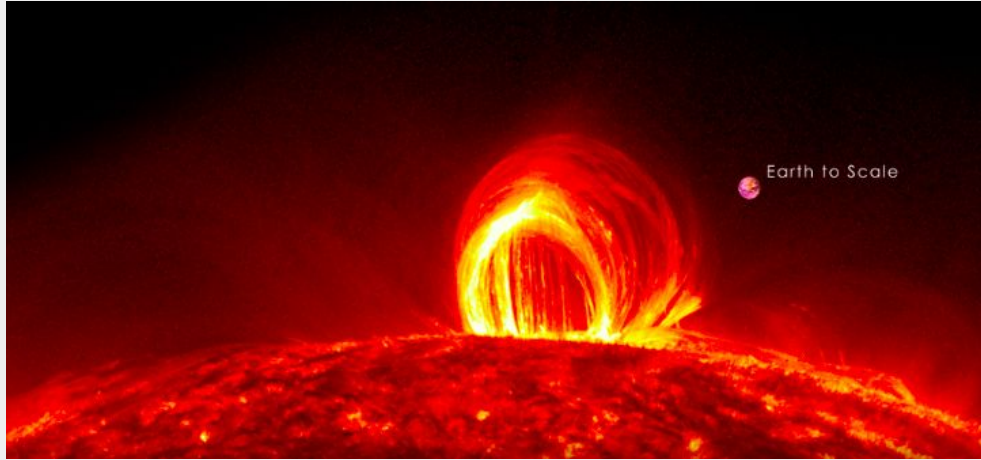
Date: 10-08-2022

# Sun



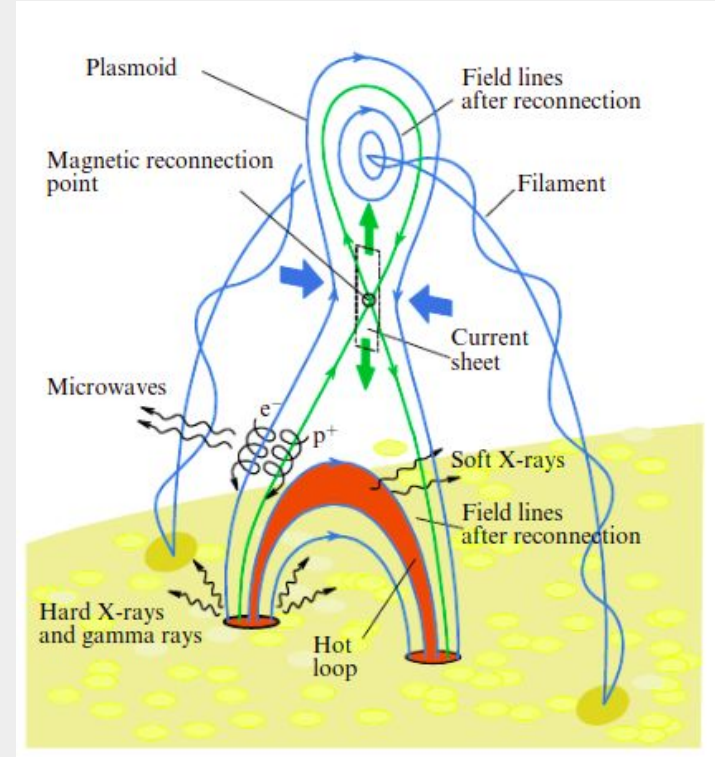
Source: Solar and Heliospheric Observatory(SOHO)

# What is a flare?



Flare (Source: NASA Goddard Media Studio)

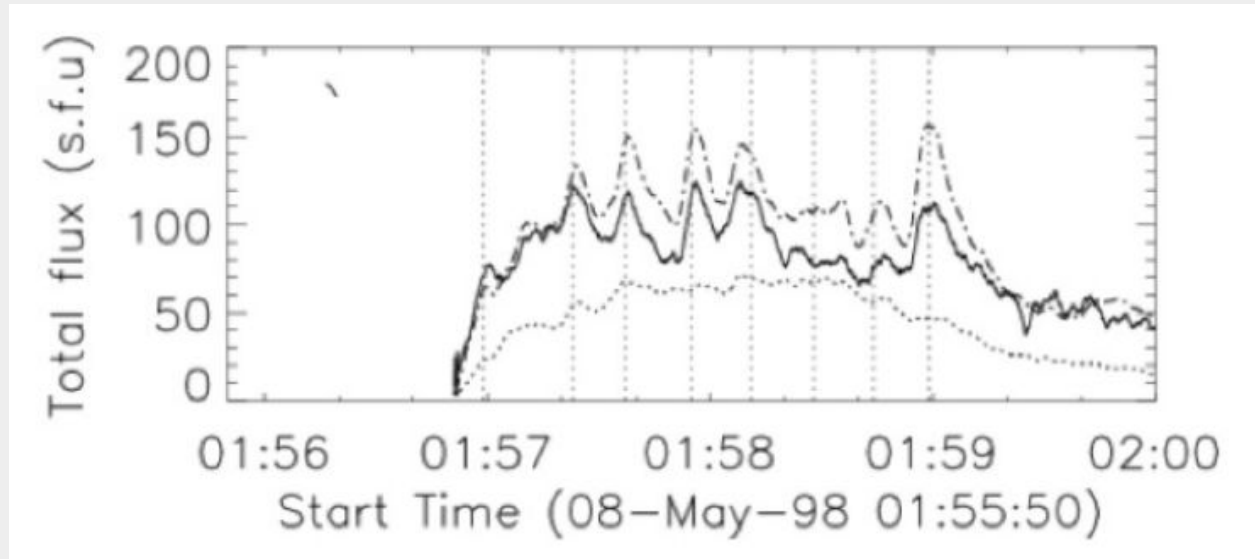
- Abrupt release of energy, radiated across all wavelengths
- Localised event, found in active region, often around sunspot
- Triggered by *magnetic reconnection*



Schematic diagram of magnetic reconnection  
(Source: A L Lysenko et. al. 2020)

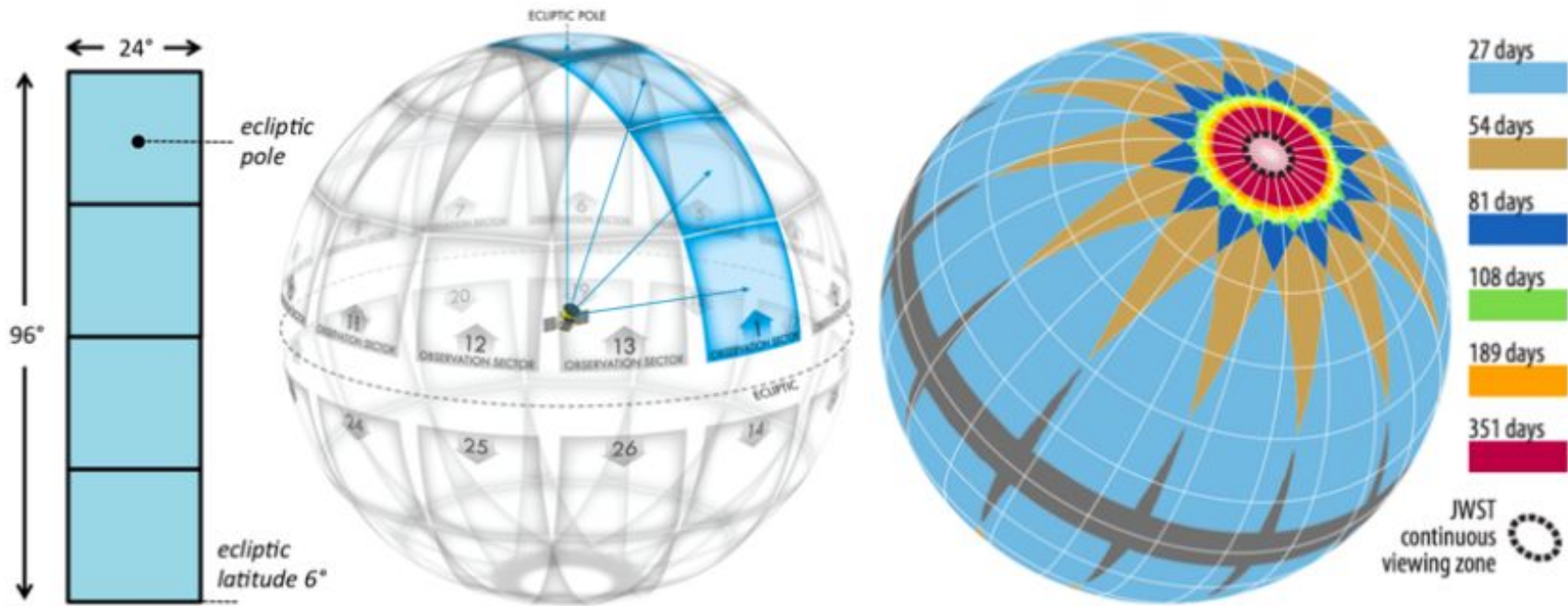
# What are Quasi Periodic Pulsations (QPPs)?

- QPPs are the irregular periodic oscillations
- In the Sun, these flares seem to have QPP nature



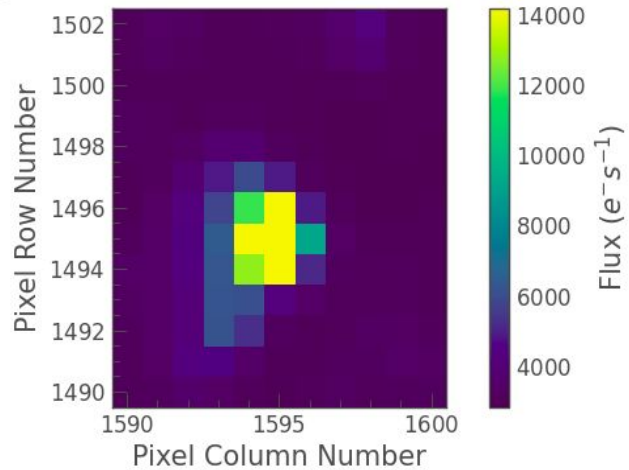
QPP in solar flare, data from Nakariakov et. al.

# Transit Exoplanet Survey Satellite (TESS)

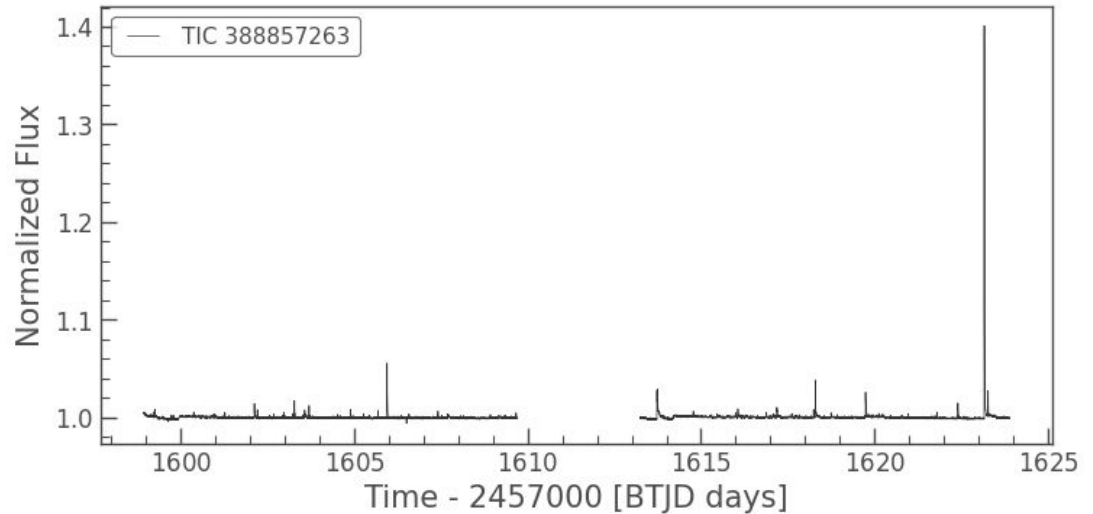


# Data from TESS

Target ID: 388857263, Cadence: 265912



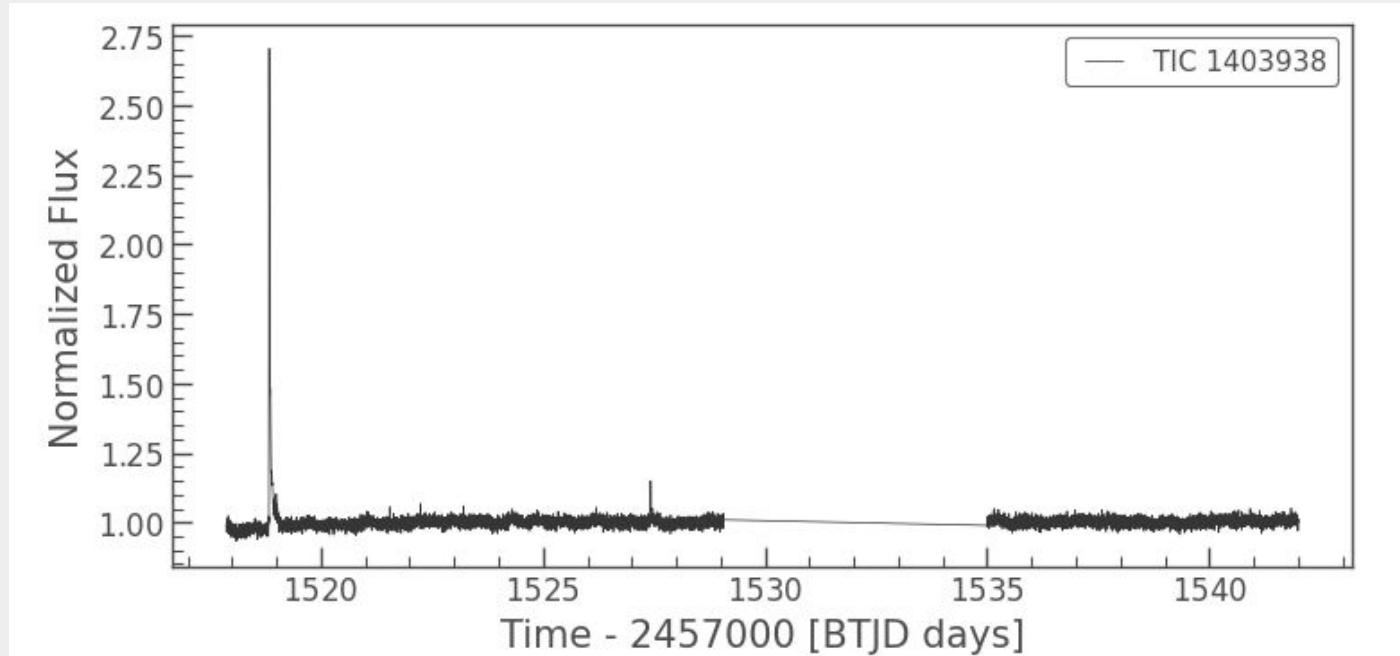
Target pixel file - Proxima Centauri



Lightcurve of Proxima Centauri (Closest star)

# Finding QPPs:

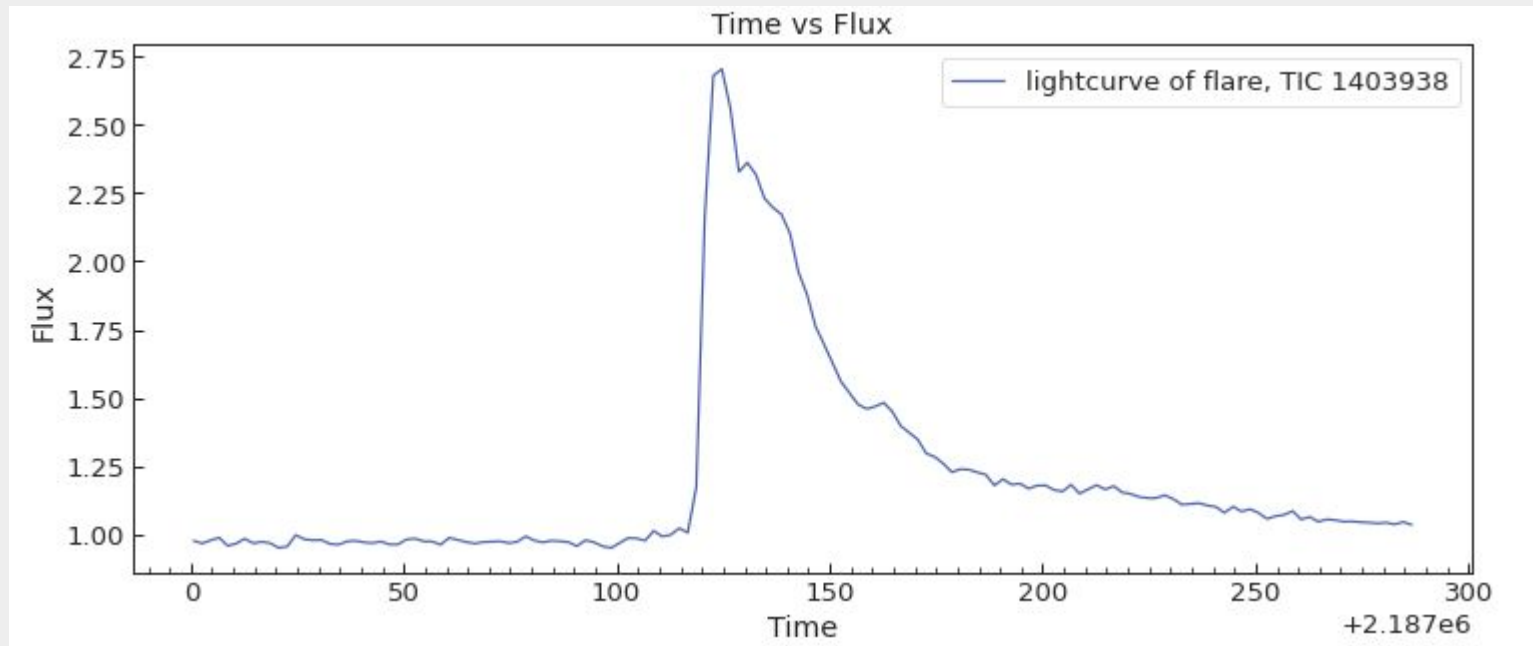
Step1: Downloading lightcurves from TESS database and finding flare region





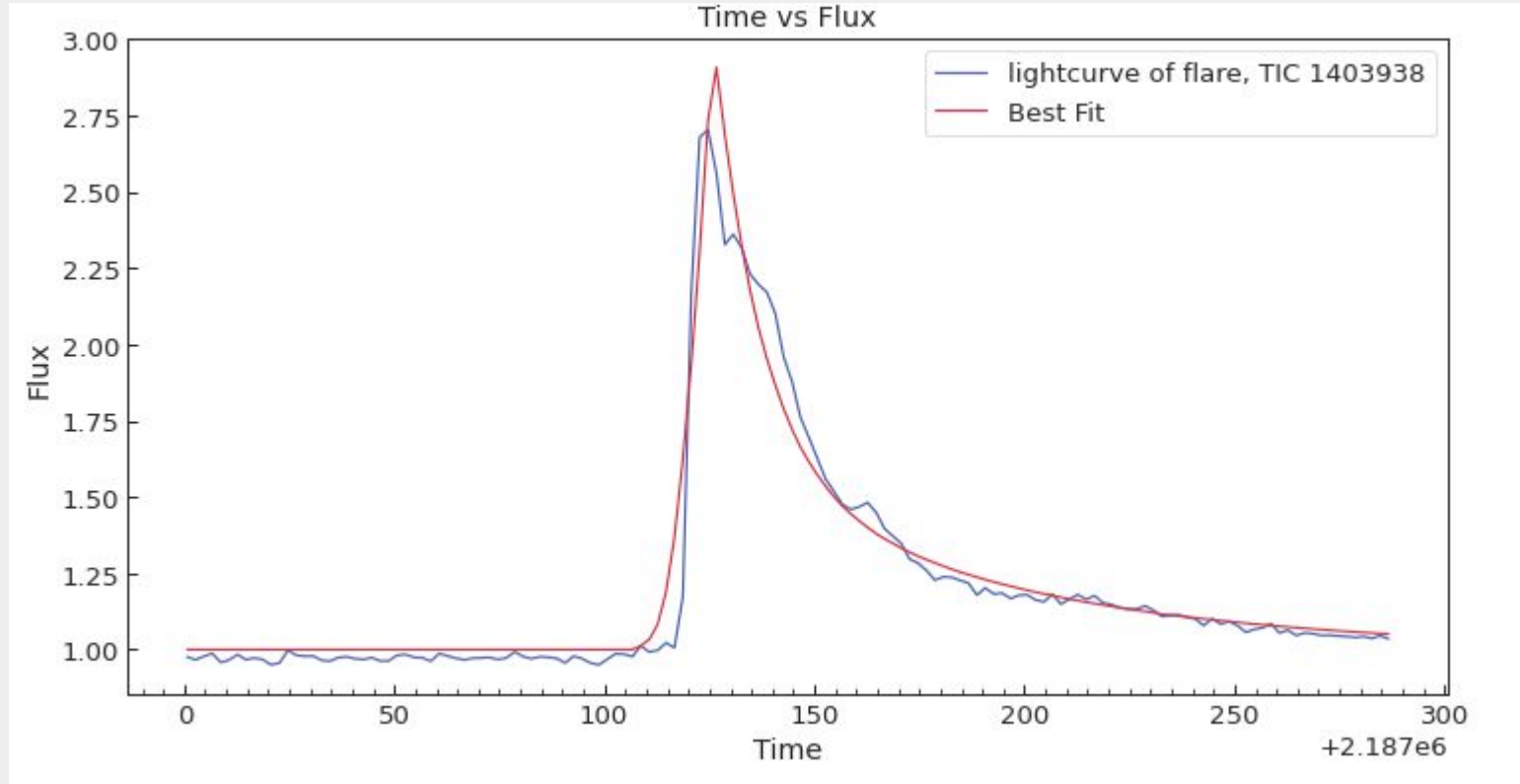
# Finding QPPs :-

Step1: Downloading lightcurves from TESS database and finding flare region

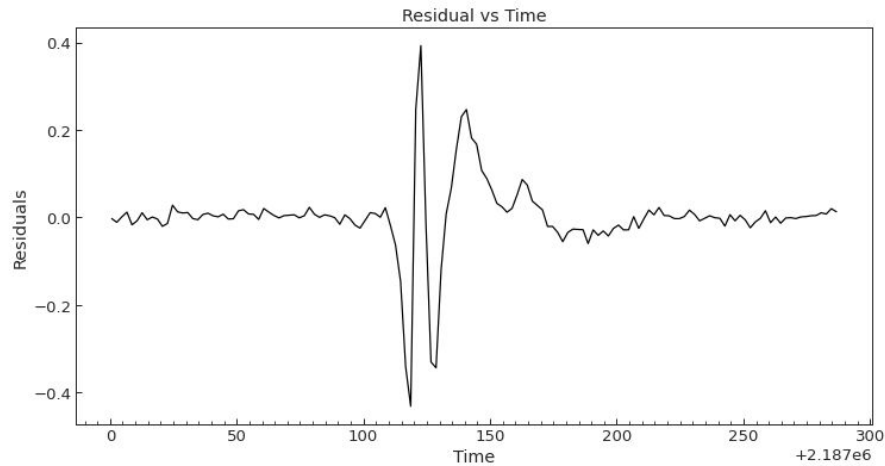




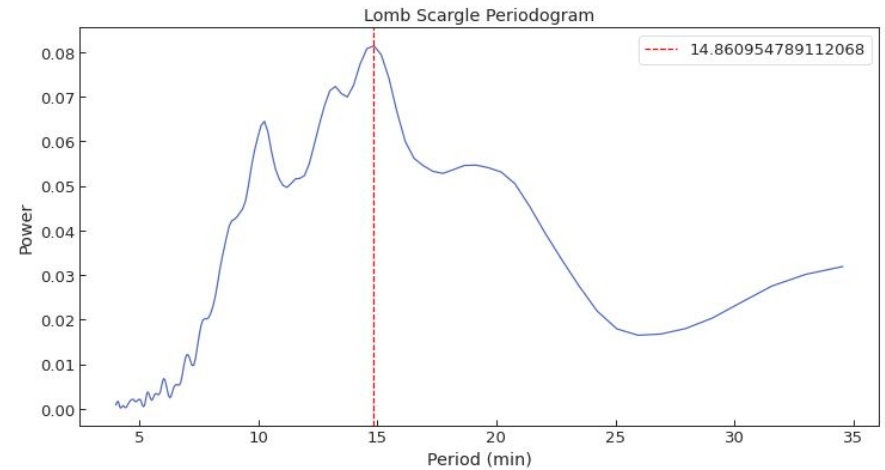
## Step 2: Finding the best fit for the flare.



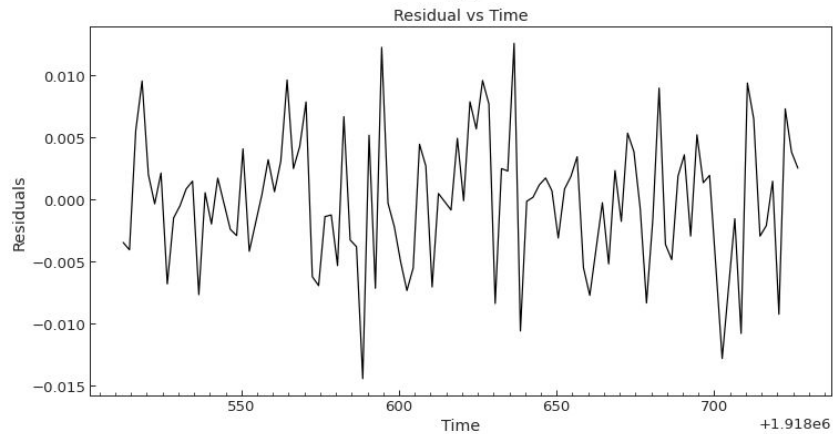
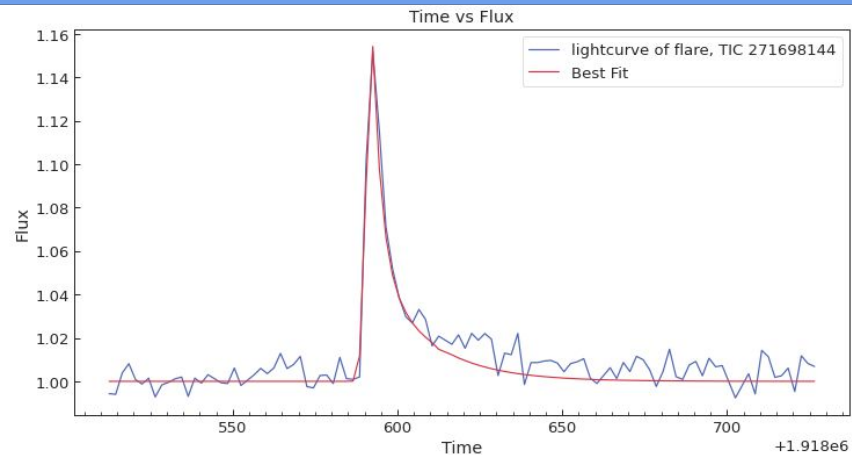
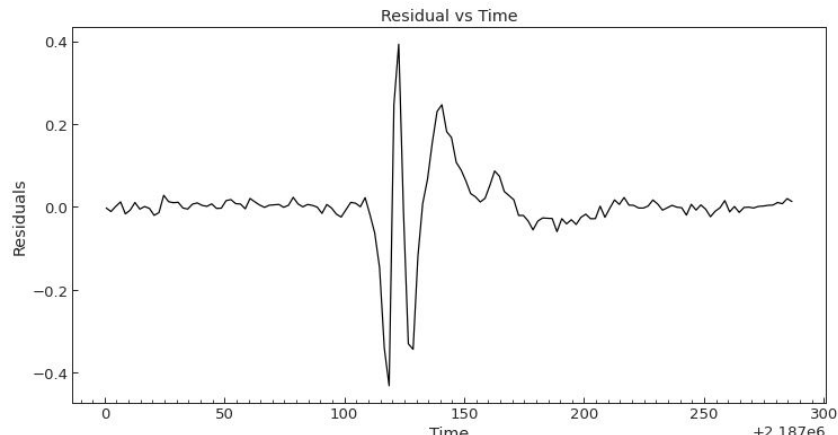
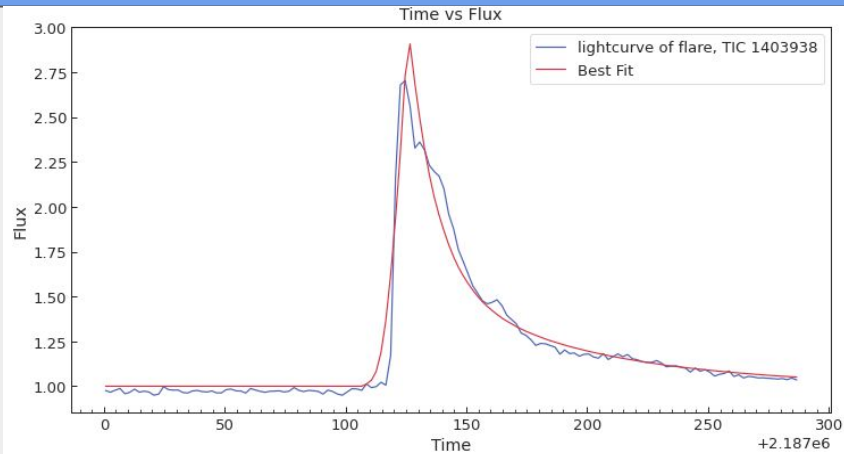
Step 3: Residuals are obtained (difference of values from best fit and actual lightcurve)



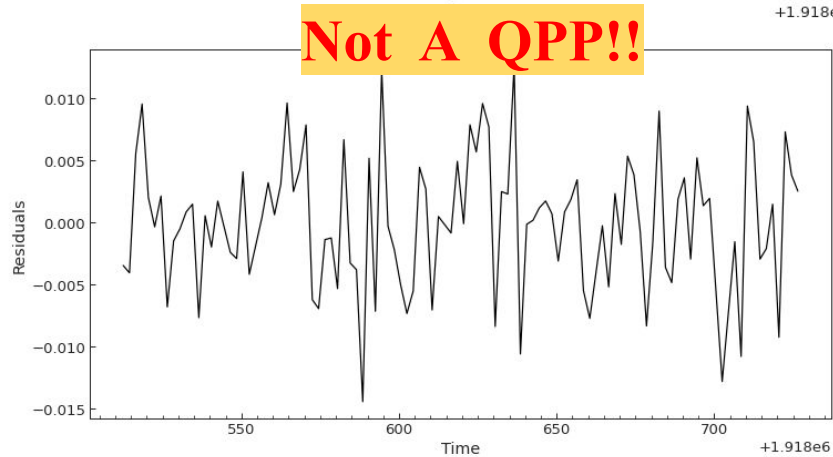
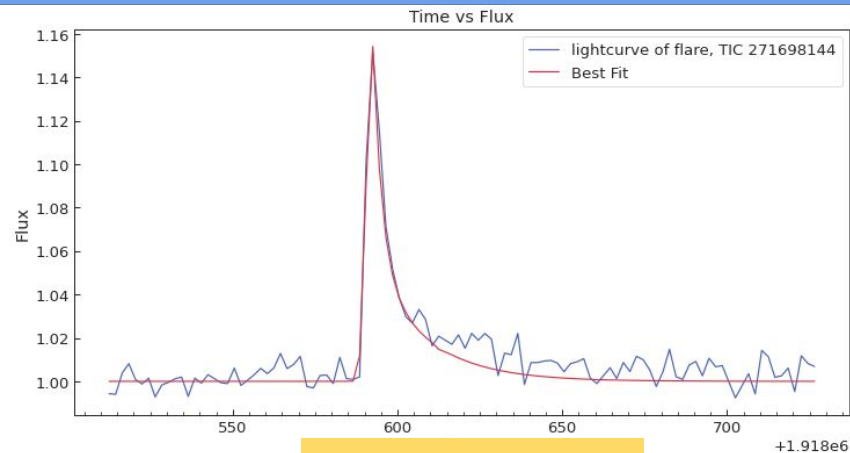
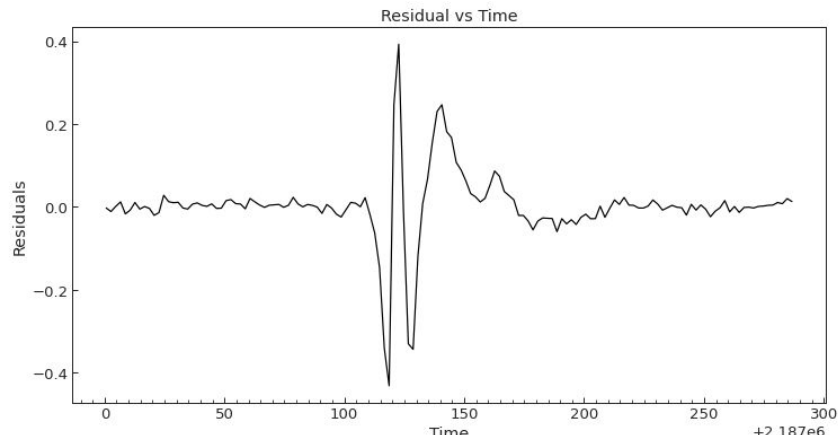
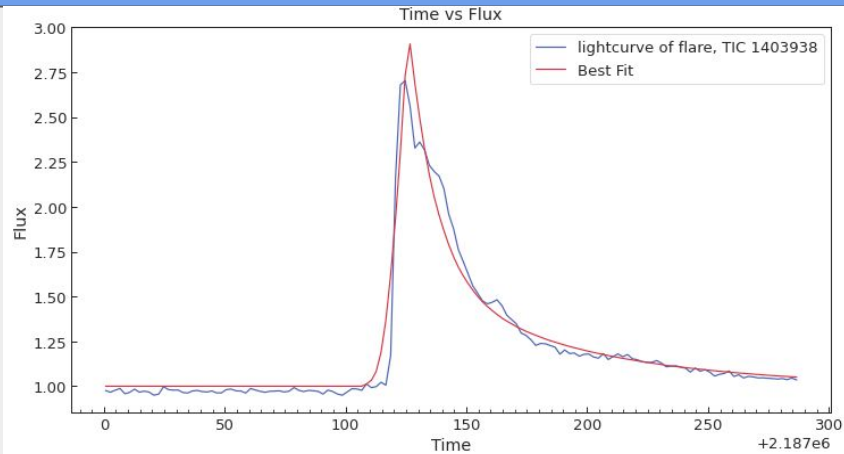
Step 4: Using a Lomb-Scargle Periodogram to find periodicity



# Other Results



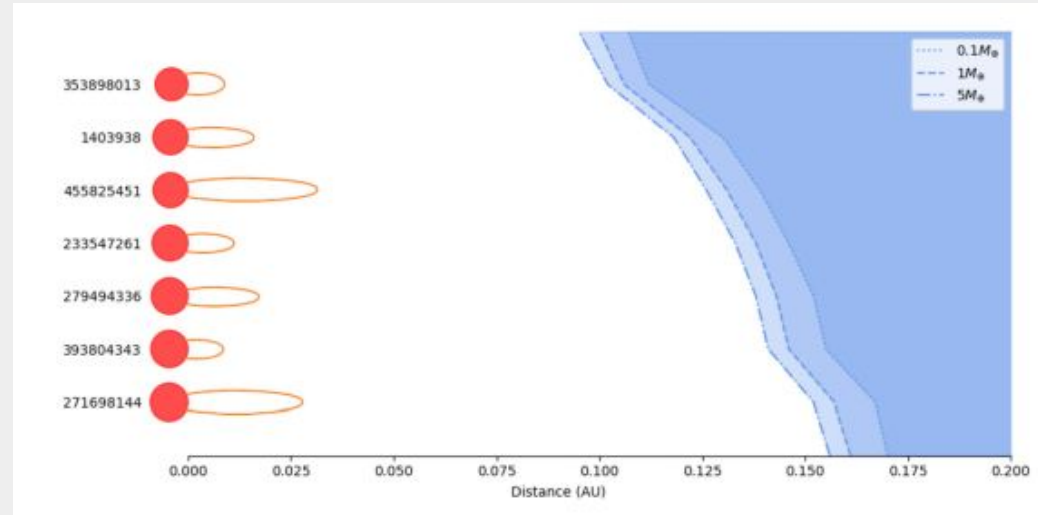
# Other Results



**Not A QPP!!**

# Importance of finding QPPs in flares

- a) What do we know?
  - Flares are present in other stars than the Sun
  - Flares may or may not have QPPs
- b) Why care about flares?
  - Flaring events can disrupt electrical power grids, satellites and telecommunication facilities
  - Establish solar-stellar connection
  - Flaring rates can deplete ozone layer - affecting exoplanet atmosphere
  -
- c) Why care about QPPs?
  - Help us determining loop lengths
  - Loop lengths can give precise estimates for Habitable zones.



Coronal Loop length and Habitable zone from the star  
(Source :- G. Ramsay et.al 2021)