Identifying Stellar Flares

Project Proposal

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Kanban Board/Timeline: STA2453 - Project Board

Question

"*Can we estimate the energy emitted by a flare?*"

As discussed with the class, the stellar flares project intends to better understand these phenomena by learning to (1) identify and then (2) map stellar flares via their brightness (~energy emitted) over time. Ideally, across stars with vastly different characteristics.

My contribution (term project): I would like to focus on (1) flare identification. If time permits, I would like to explore the application of previously established (2) flare mapping models to the output of my own mapping model.

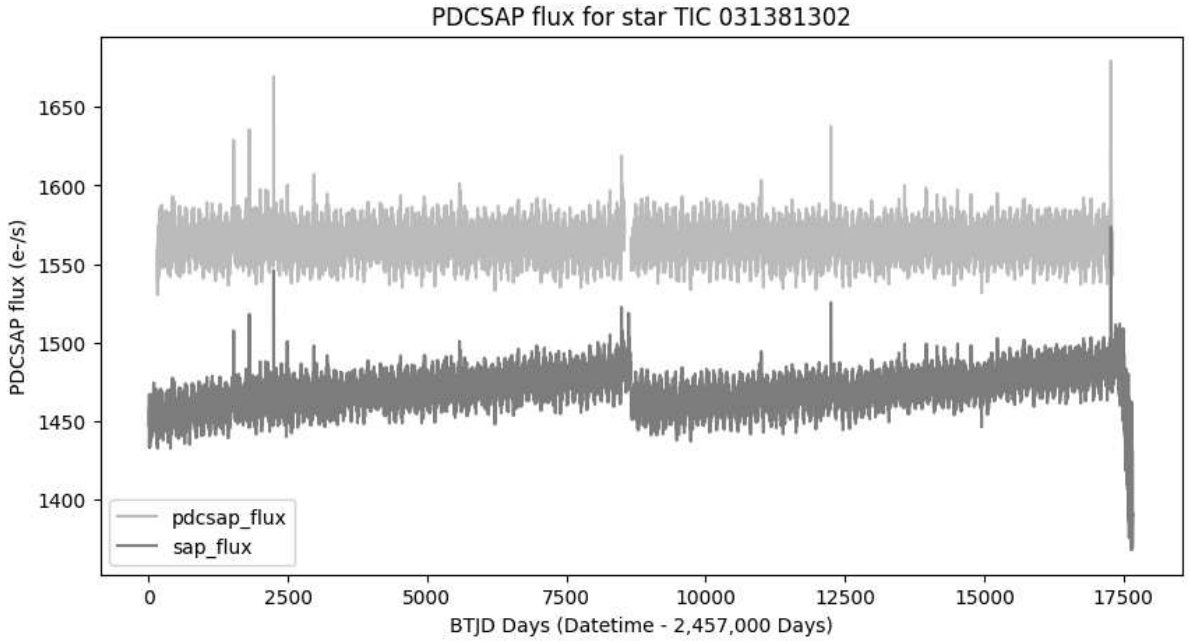
Personal goal: Learn how to work with time series in practice. Read up on more applicable time series models, be flexible and adapt new ideas to include them when/where possible.

Data

The provided data comes from the TESS Mission, a survey searching for planets transiting nearby stars. Specifically, this refers to a satellite observing different segments of the hemisphere, ~27 days at a time. The time series of interest is the **Pre-search Data Conditioning SAP (PDCSAP) flux**, which is equivalent to SAP flux with long-term trends, primarily corresponding to measurement error (scattered light), removed. Simple Aperture Photometry (SAP) flux is a measure that aggregates the total brightness (electrons/sec) of every pixel within an image that is identified to be a part of a collective astral object. These observations are taken with a 2-minute cadence. Importantly, flares are not labelled, making this an unsupervised learning setting. Additionally, there are significant gaps in the data due to orbit, technical challenges, etc.

In [17]:
```
## Plot
from IPython.display import Image
Image("proposalTS.png")
```

Out[17]:



Methods

Pre-treatment

- Model trends and seasonality (e.g. smoothing, backfitting)

Helpful for removing noise, isolating leftover unidentified trends, such as flares.

Modelling

- Unsupervised Event Detection: SVM, Isolation Forest, etc.

I've read about Event/Anomaly detection models, they seem well-suited for stellar flare detection. If there is an opportunity to incorporate Deep Learning, it may be a good learning experience.

Model Evaluation

- Comparison with existing models, e.g. detrending + sigma-clipping, CNN (Neural Networks), etc.

Model Combinations (if time permits)

- Spectral analysis
- Other publisehd models