Searching for Stellar Cycles Using Changes in Flare Rate

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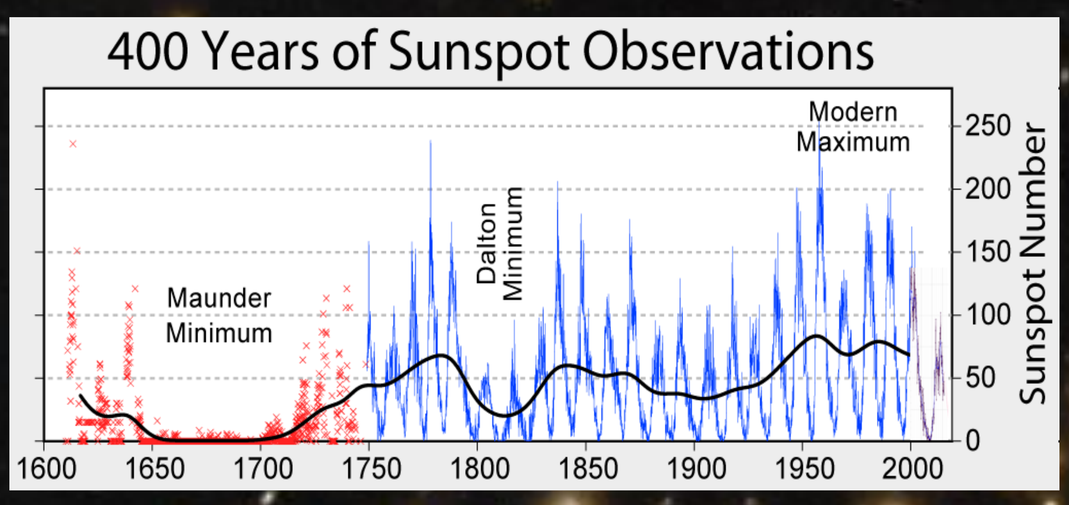
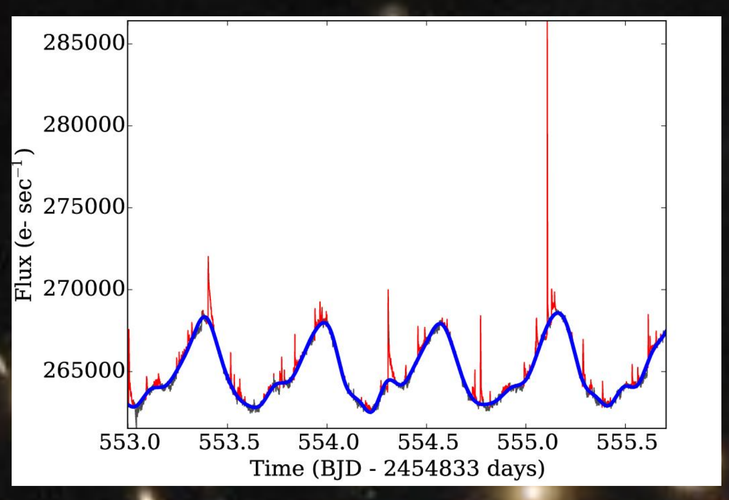
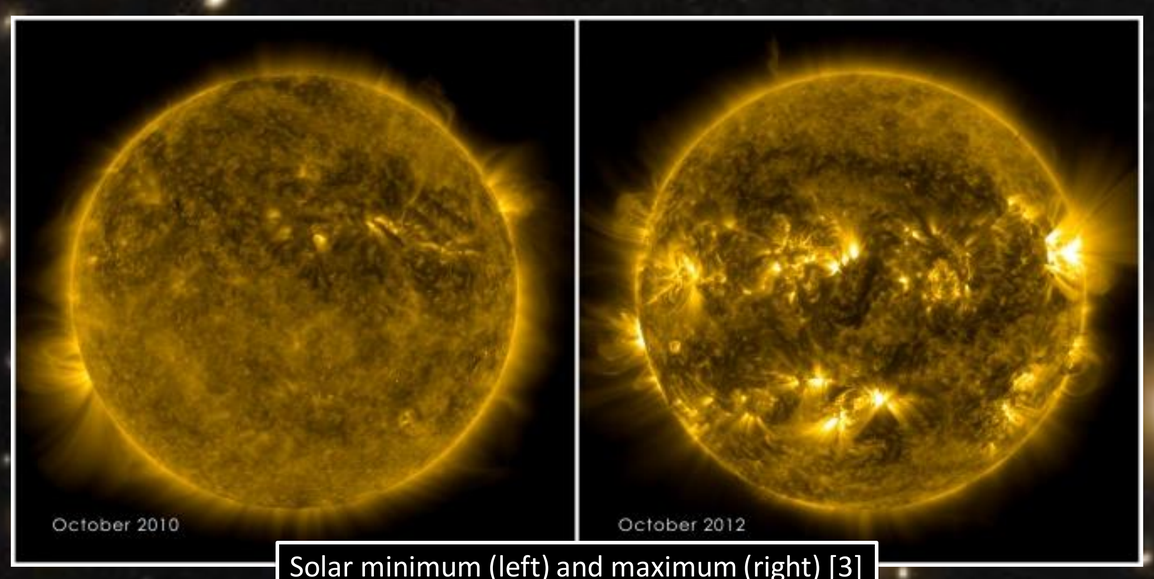
Introduction

Periodic changes in our Sun's magnetic field create an 11-year solar cycle. This cycle is shown by changes in surface activity, historically tracked using the number of sunspots over time. Flares rates also vary by a factor of 10 between solar maximum/minimum. We use this property to search for stellar cycles in other stars with flares.





Above[1] shows the record of sunspot count, which is used to track the solar cycle. 1645 to 1715, the Maunder Minimum, was a period of little surface activity. Looking for stellar cycles in other stars will give insight into how common this behavior is.

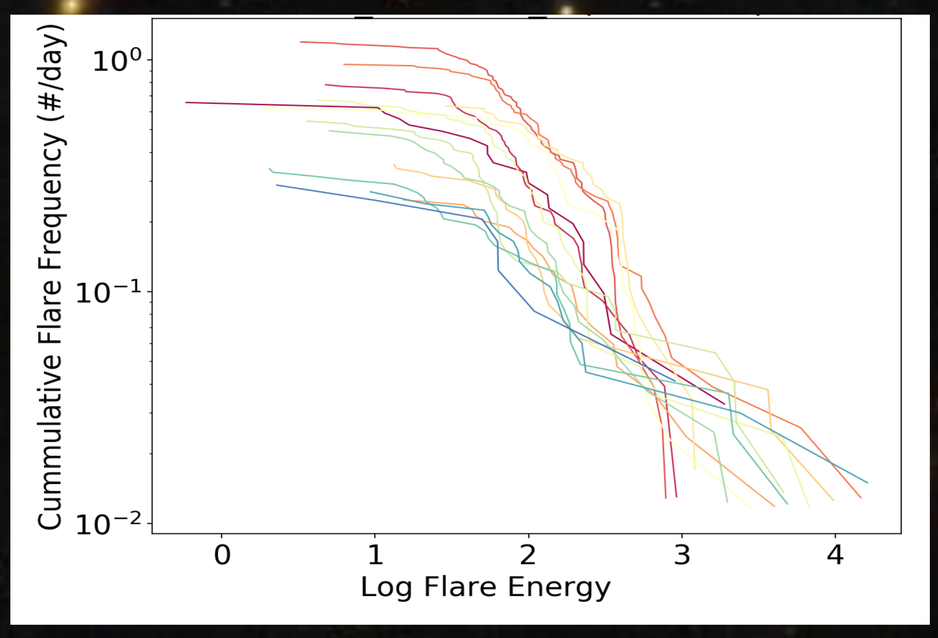


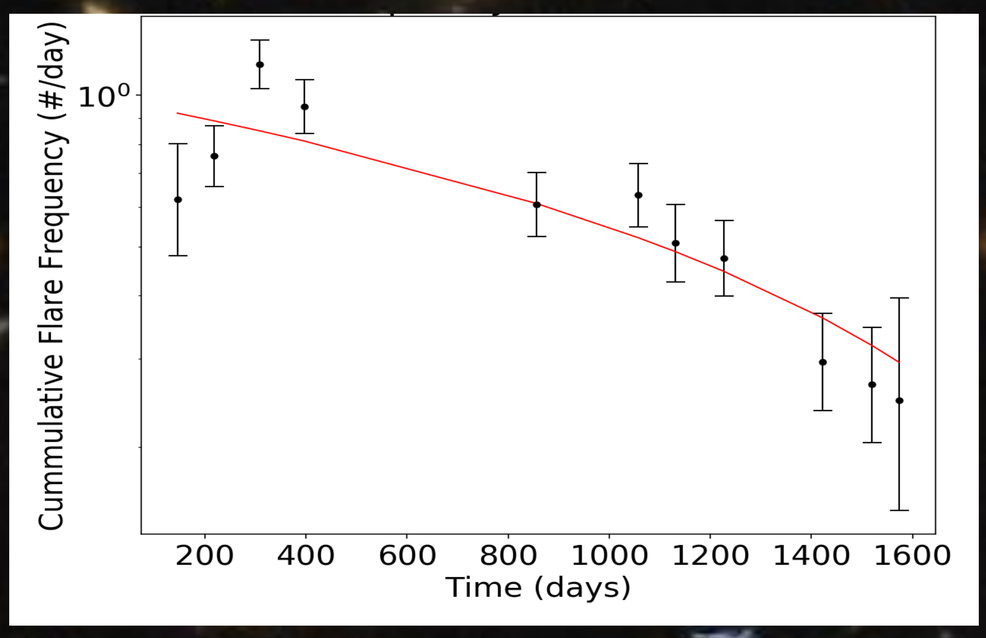
Solar minimum (left) and maximum (right) [3]

Above[2] is a Kepler light curve. The spikes in this light curve represent flares. Kepler provides 4-year periods of observation for each star. Although it's unlikely to observe a full cycle, it should be long enough to show a trend in the flare rate.

Data Analysis

We use light curves from NASA's Kepler mission to gather flare counts for 350 stars from Davenport (2016). The bottom left plot shows a reverse cumulative sum of the flares over time for a single star over a 4-year period. The lines are colored by the date the data was taken, red to blue. The bottom right plot shows the same data but at a fixed energy value, plotting rate vs time. We fit many time-dependent models to this panel, and use the Bayesian Information Criterion to choose the best while preventing overfitting.





References:

[1] Rohde, R. Wikipedia (2016)
[2] Davenport, J., ApJ, 829, 23 (2016)
[3] NASA/SDO (2012)