Finding outbursts or flares

TSDA 2020

Outbursts/Flares

- These may be periodic or not
- Examples include outbursts from X-ray binaries, dwarf novae from cataclysmic variables and flares from M stars.

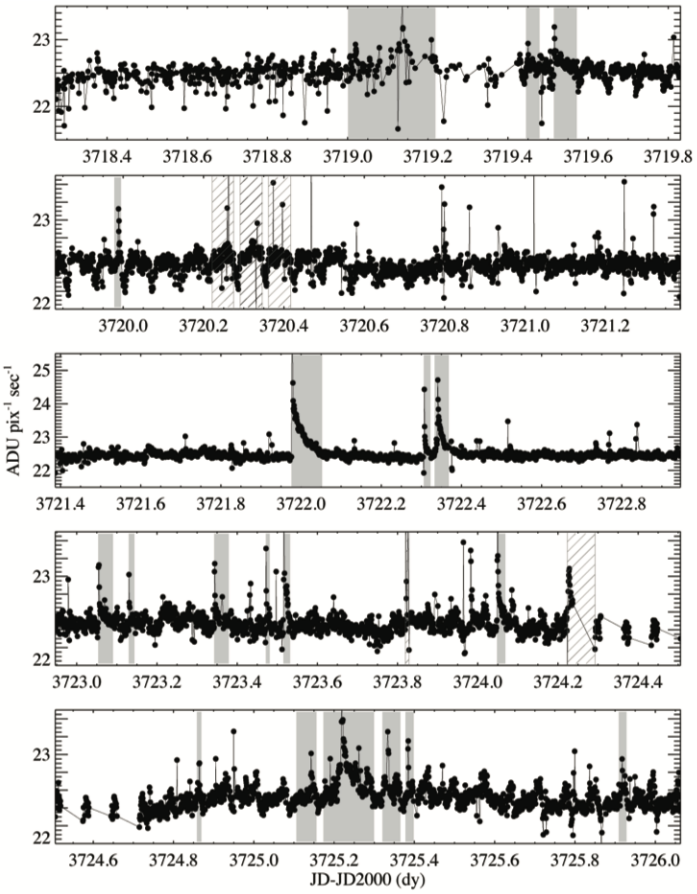
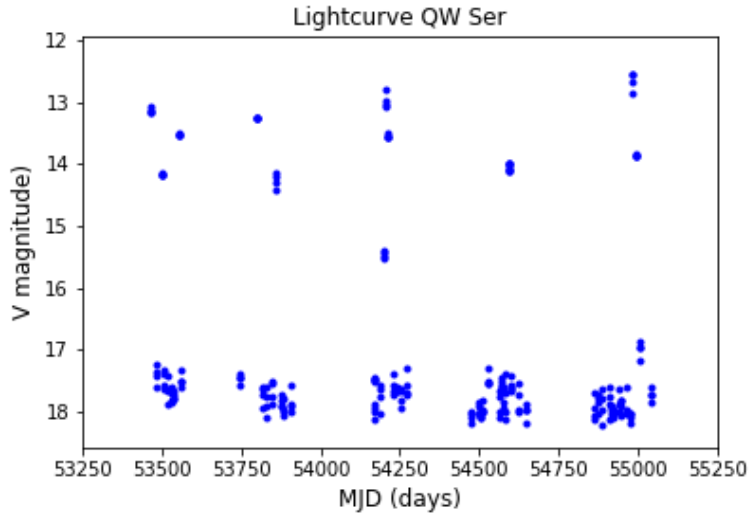


Fig. 5.— The model-subtracted light curve with stray light modulation. Solid shaded regions identify the 19 flares that passed visual inspection out of the original 24 candidates. The rejected flare candidates are shown as hatched regions.

Flare stars

- magnetic reconnection events
- MOST
- More energetic flares are less frequent
- Do these flares provide evidence for magnetic cycle?

Cataclysmic variables

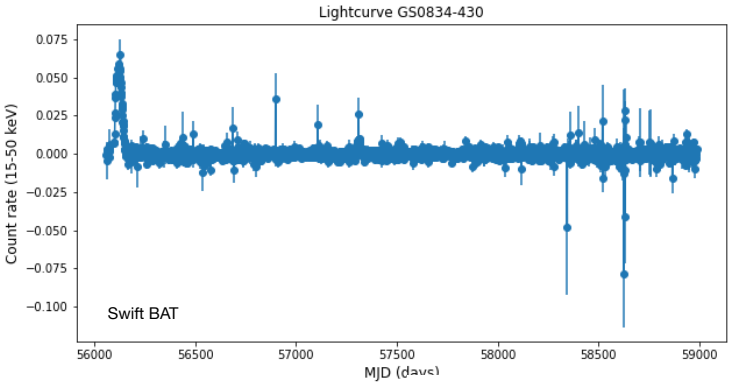


5 years

- Irregular outbursts
- White dwarf accretes through Roche lobe overflow
- Outbursts due to instabilities in the accretion disc

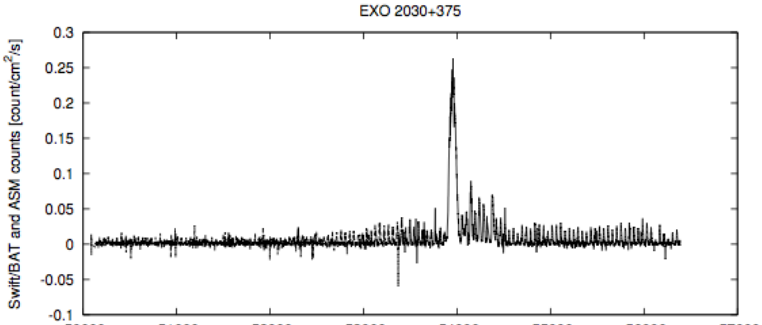
X-ray binaries

8 years



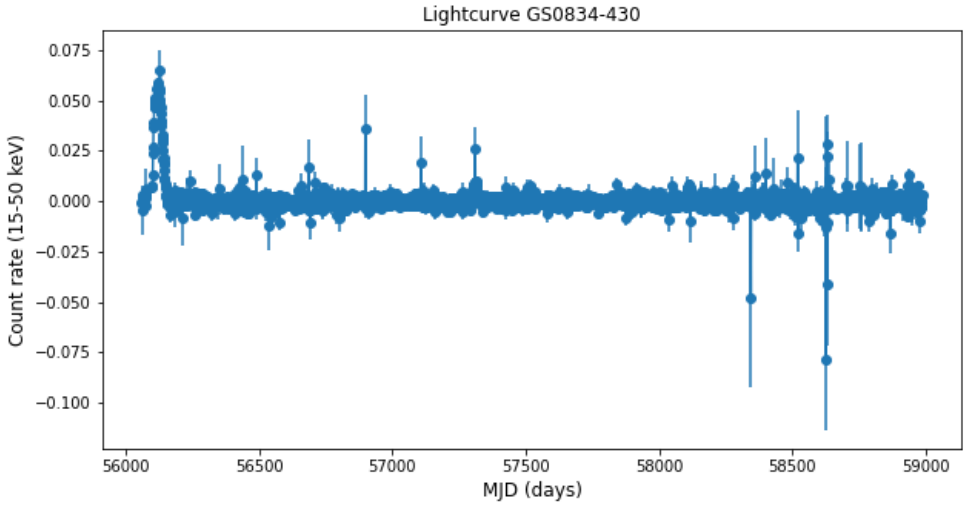
Some show rare outbursts.
Any others hiding in the noise?

Periodic outbursts (sometimes)



20 years

Sigma clipping



1. Take a weighted mean and standard deviation
2. Which points are more than X standard deviations away from the mean?
3. Remove those points and repeat
4. Decide when to stop

Weighted mean

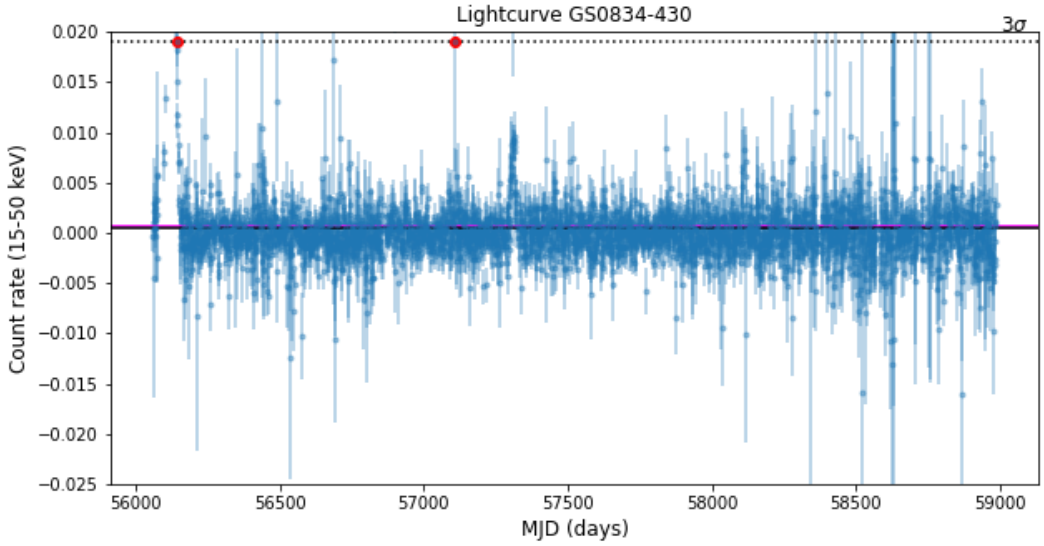
$$\bar{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

where w_i are the the weights

In the example that follows we weight the mean by the 1/(error bar), which is fairly standard.

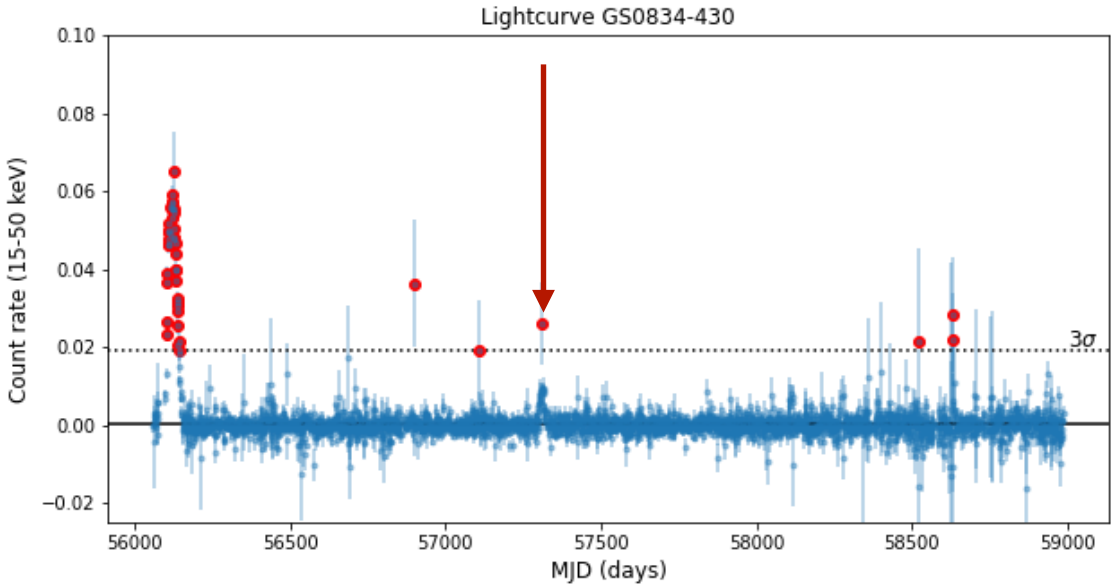
Points with large error bars make less of a contribution.

1. Weighted mean



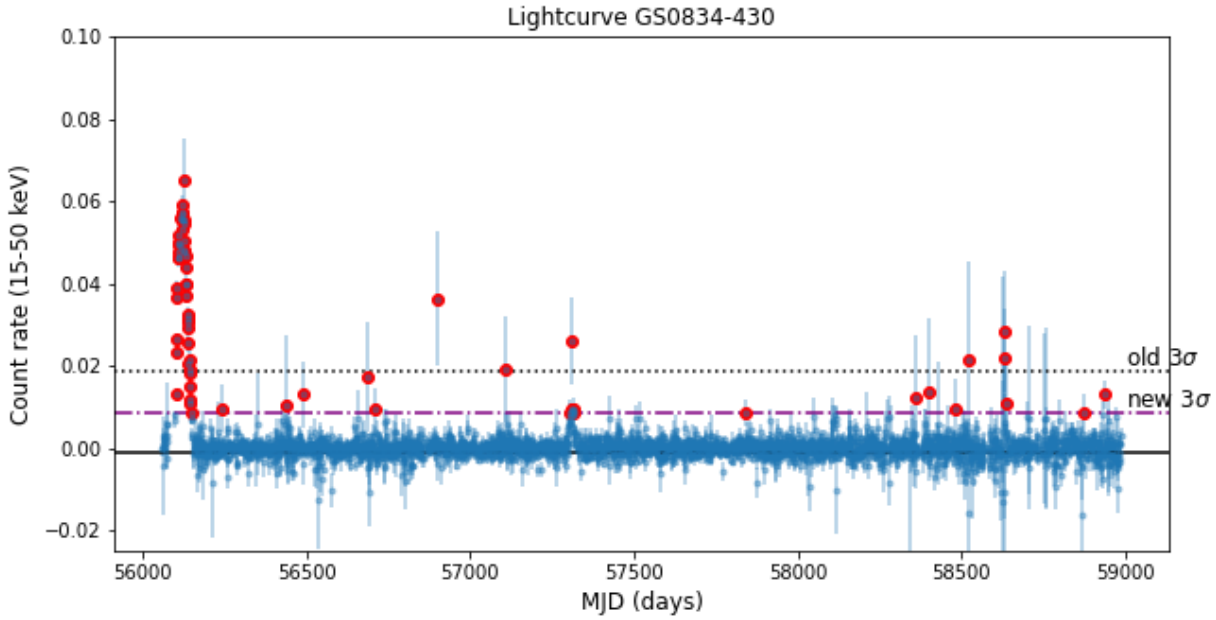
Here there's not much difference between the mean and the **weighted mean.**

2. Which points are >X sigma from weighted mean?

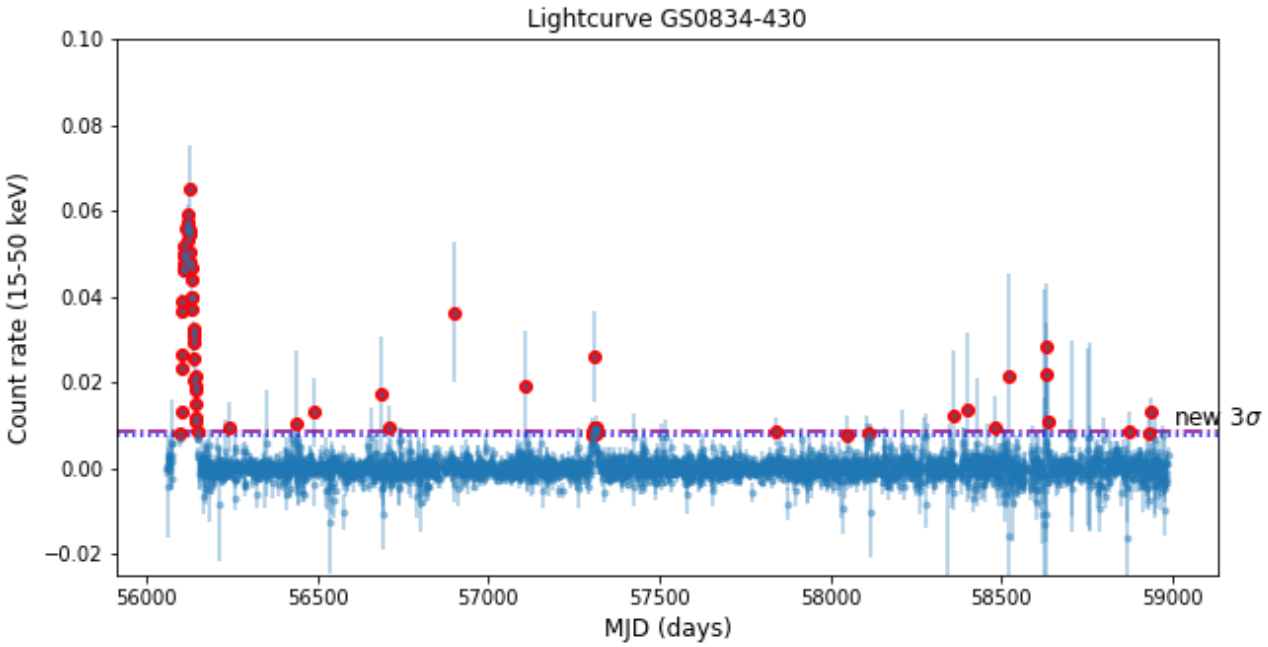


Here X = 3

3. Remove these points & repeat



3. Remove these points & repeat

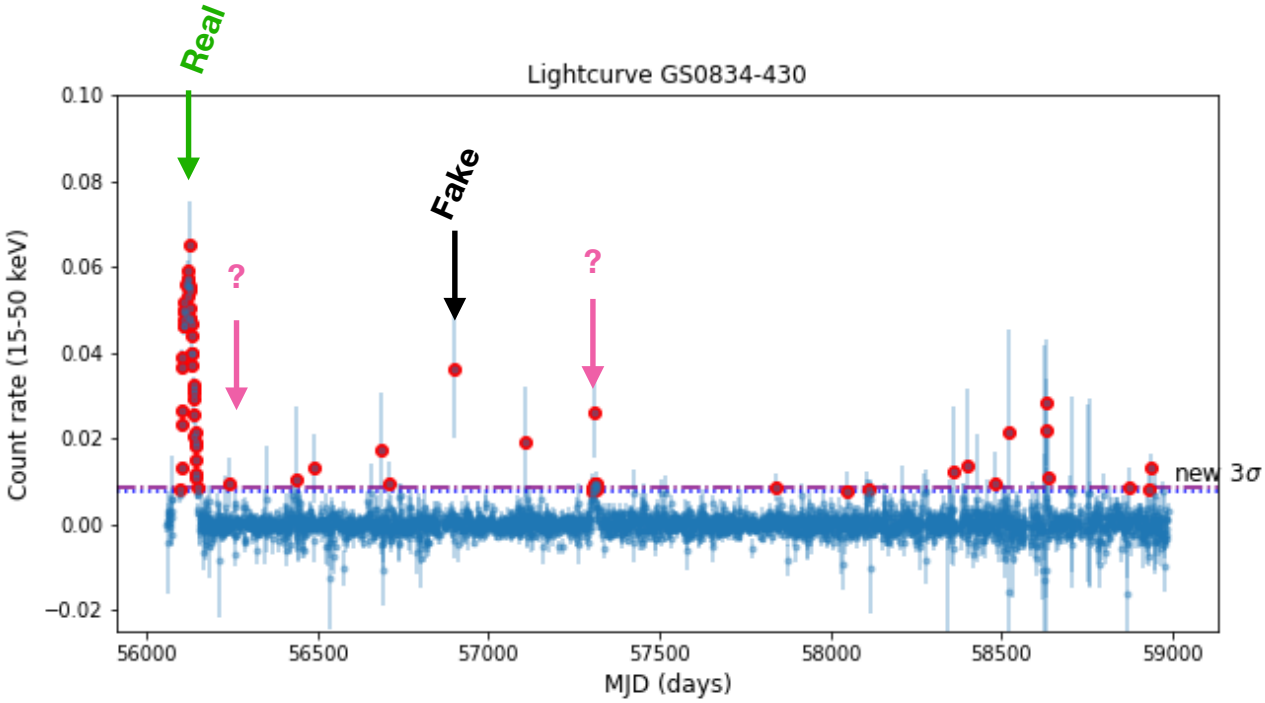


4. Condition for stopping

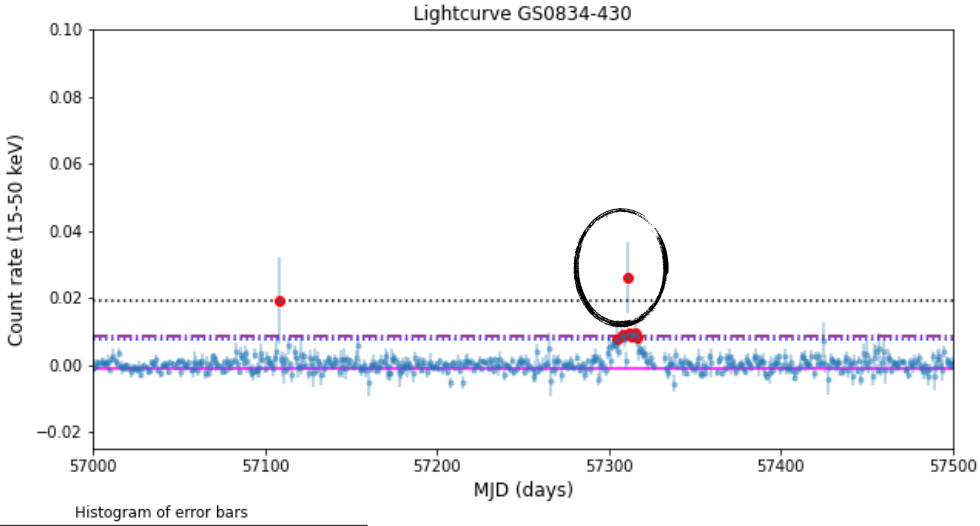
Define some condition at which point you stop iterating, e.g.

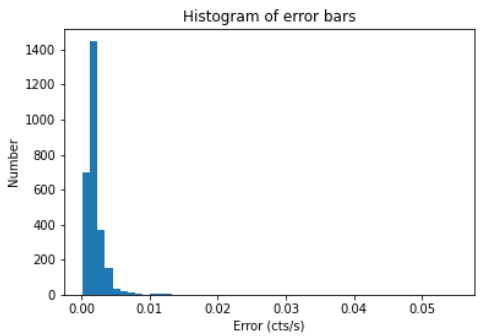
- If `number_of_clipped_points < X`, stop clipping
- If `new_mean/old_mean` < X%, stop clipping
- etc.

Outbursts: real or fake?



Outbursts: real or fake?





These error bars are ~0.01

Typical error bars are < 0.005

Outbursts: real or fake?

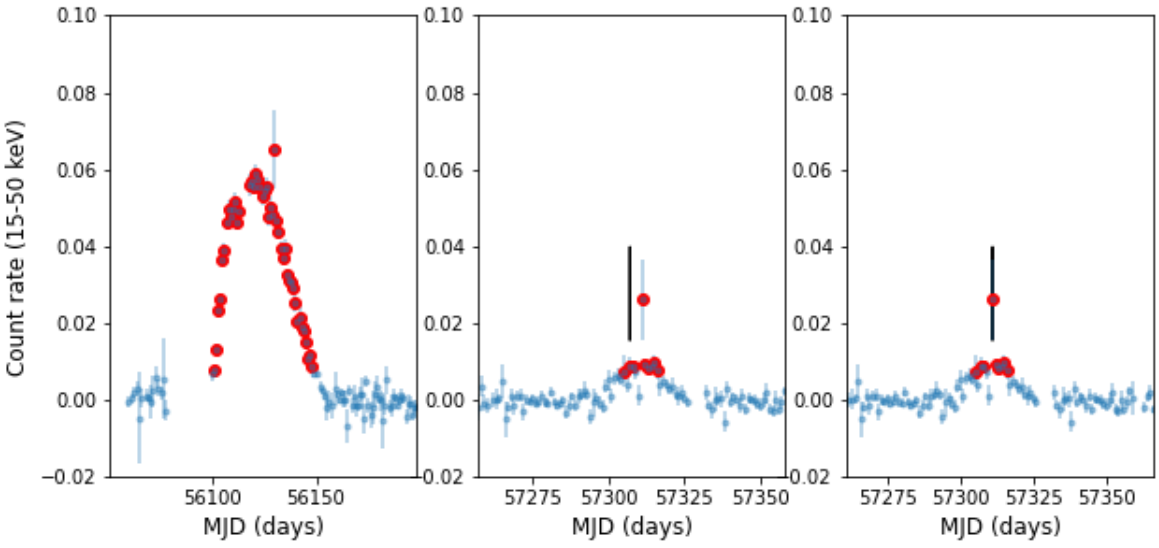
Also, real outbursts are expected to be longer than 1 day with smaller error bars.

Let's check for clustering in time of the "outbursts".

My very rough and ready algorithm finds 3 separate outbursts:

43 days, 2 days and 6 days.

Outbursts: real or fake?



1 **2** **3**

Actually it's only two outbursts.

Practice

Have a go at working through the Jupyter notebook:

`Swift GS0834 sigma clipping`

This will also help you with the tutorial questions.