

Background

Flares are short-duration brightenings caused by sudden energy release in stellar atmospheres. Classical stellar activity theory predicts flaring mainly in stars with outer convective envelopes and magnetic dynamo action. Normal A-type stars have predominantly radiative envelopes and are therefore not expected to show intrinsic flaring.

Aim and Objectives

- ▶ Identify flare events in normal A-type stars.
- ▶ Characterize flare properties.
- ▶ Assess whether the detected flares are intrinsic.

Data

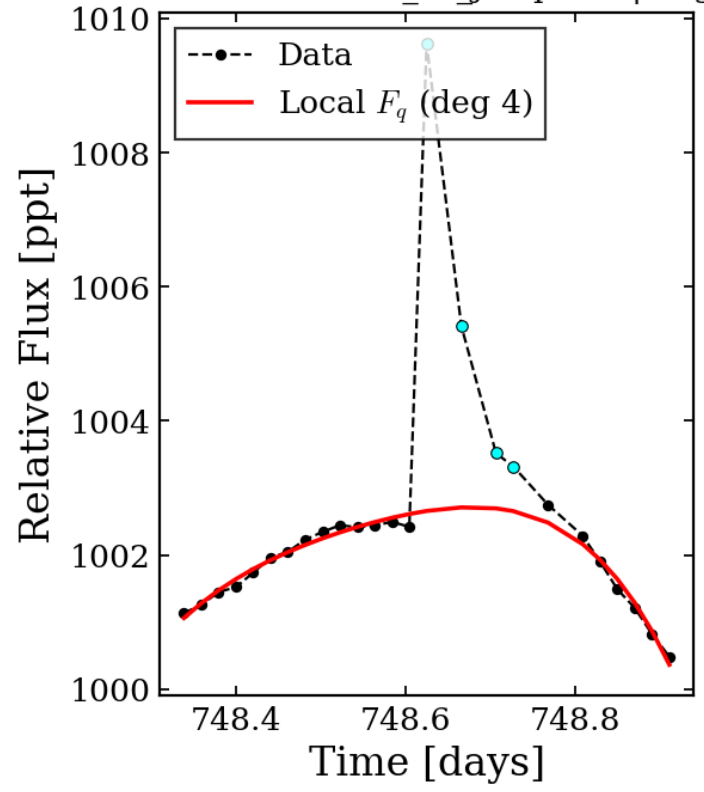
- ▶ *Kepler* long-cadence and short-cadence photometry
- ▶ Target Pixel Files for contamination checks
- ▶ FIES spectroscopy where available

Methods

- ▶ Quality masking and removal of flagged points
- ▶ Jump correction of discontinuities
- ▶ Segmentation at significant time gaps
- ▶ Polynomial detrending (degree 1–5)
- ▶ Flare detection using $3 \times 1.4826 \times \text{MAD}$
- ▶ Flare filtering following strict criteria
- ▶ Pixel-level vetting of flare origin
- ▶ Spectroscopic checks using radial velocity and line diagnostics

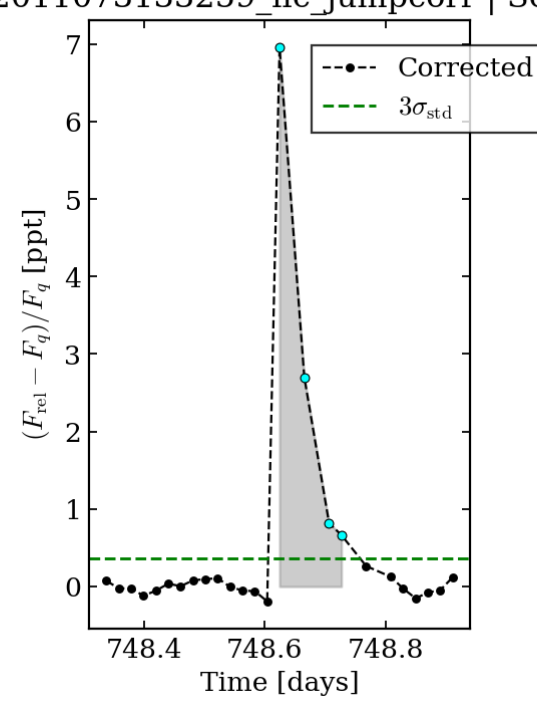
Example Light-Curve and Flare Detection

kplr006185416-2011073133259_llc_jumpcorr | Segment 1 | Flare 1



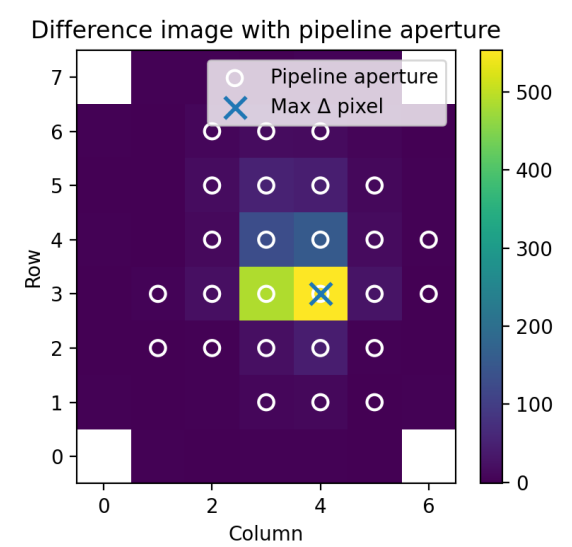
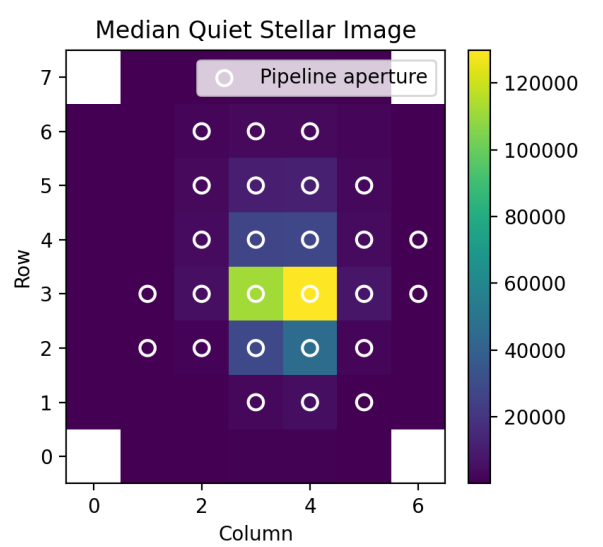
(a) Local flare view

kplr006185416-2011073133259_llc_jumpcorr | Segment 1 | Flare 1



(b) Corrected flare panel

Pixel Vetting



The flare signal is concentrated in central aperture pixels and aligned with the target PSF, indicating that the event is likely intrinsic rather than contaminated.

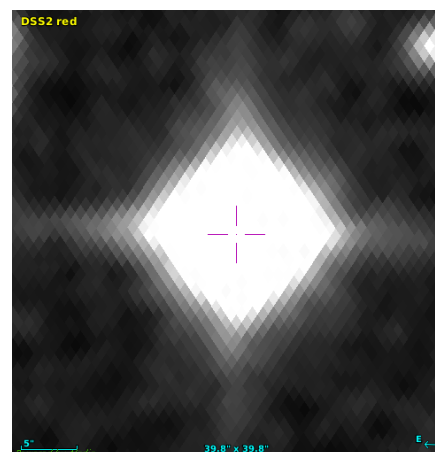
Neighbourhood Inspection



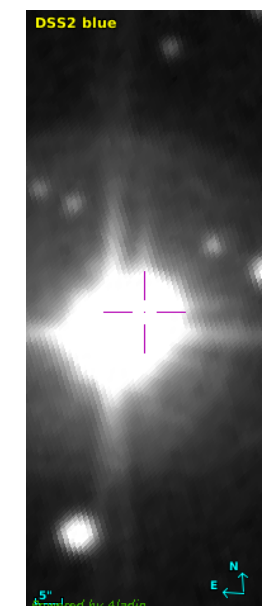
(a) 2MASS



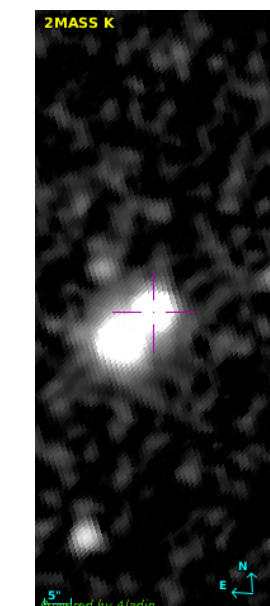
(b) DSS2-blue



(c) DSS2-red



(d) Mask-blue



(e) Mask-red

Multi-filter neighbourhood views used to assess nearby sources and possible contamination within the Kepler mask.

Key Results

- ▶ 28 stars were analysed photometrically.
- ▶ 14 stars showed at least one flare-like event.
- ▶ 14 stars showed no detectable flare activity.
- ▶ This corresponds to a flare fraction of about 50%.
- ▶ Pixel vetting shows that not all flare detections have the same origin.

Photometric Summary

KIC	T_{eff}	N_{Flares}	$\log \Delta F / F$
6185416	6780	6	-2.1579
10724625	7661	2	-1.4927
5545866	7155	9	-2.0684
9778156	6777	6	-1.8293
5689219	7613	1	-2.9829

Spectroscopic Results

Multi-epoch spectroscopy revealed that some targets show significant parameter changes, including radial velocity variability, suggesting that not all flare detections necessarily arise from the same physical origin.

Conclusion

Flare-like events are present in a substantial fraction of stars classified as normal A-type stars. Careful photometric processing and pixel-level vetting strengthen the case that some events are intrinsic. However, spectroscopy indicates that binarity or unresolved companions may explain some cases. Current stellar activity models do not fully explain these observations.

Future Work

- ▶ Expand the sample using *Kepler* and *TESS*
- ▶ Obtain more multi-epoch spectroscopy
- ▶ Revisit models of magnetism in intermediate-mass stars