The Rotational Phase Distribution of Stellar Flares on M dwarfs with K2

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M dwarfs

- Stars after M4 spectral type (<0.3Msun) become fully convective;
- However, late M dwarfs do show activity!
- They **must** generate a magnetic field in a different way to the Sun.

- < 0.5Msun
- 2400K - 3800K
- 70% stars
Flare Rotation and Dependency on Phase

Clear rotation modulation caused by the presence of a long lived star spot.

Flares present here when the star spot is not visible.

Ramsay et al (2013)
Stellar Flares Using K2: Part 1

- K2 short cadence (1min) data on 31 M dwarfs.
- Stellar flares are used as a proxy for stellar activity.
- Calculate Rotation Periods.
- Identified flares using FBEYE (Davenport et al. 2014).
- Multi-wavelength fluxes from PanStarrs.
- Flare Energies:

\[ E_{\text{flare}} = L_{\text{star}} \times t \]

Doyle et al. (2018)
Stellar Flares Using K2: Part 1

- Large flares seen at maximum amplitude of rotational modulation.
- Flares are seen at **ALL** rotational phases.

**NONE** of the stars in our sample showed a preference for rotational phase.

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**Where do the flares originate?**

1. Binary system?
2. Orbiting planets?
3. Polar spots?
4. Multiple spot locations?

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**V497 Tau**

Doyle et al. (2018)
An additional 18 M dwarf flare stars from Campaigns 10 – 18.

Doyle et al. (in prep)
Stellar Flares Using K2: Part 2

- Computed a simple $\chi^2$ test to determine if the distribution of flares was random.
- Split flares into low and high energy with a cut off of $10^{32}$ erg.
- Again none of our sample show any preference for rotational phase.
Flaring Variability

- Handful of stars observed in multiple Campaigns.
- Allow us to investigate the flaring variability in these particular stars.
- Over time both stars have shown changes in the range of flares observed with K2!

Doyle et al. (in prep)
First Results from TESS

- Sample of 150 low mass stars from Sectors 1 - 3 with 2-min cadence - 3 times larger than our K2 sample.
- Observation length of 27 days as opposed to ~70 d.
- TESS is less sensitive to lower energy flares.

Doyle et al. (in prep)
First Results from TESS

- Similar analysis to K2 sample and preliminary results show the flares are randomly distributed.
- Individually, NONE of the stars show any preference for rotational phase even when split by spectral type or rotation period.

Doyle et al. (in prep)
Conclusions

• There is no correlation between the rotational phase/ energy or number of flares. All stars show significant rotational modulation due to a star spot so, this is a surprise.

• A number of stars in our sample are rapidly rotating (< 0.3 day) but produce low number of flares. These stars would prove interesting targets for spectropolarimetry observations.

• With TESS data being released every few months it will increase the sample of low mass stars observed in 2-min cadence to continue to answer the question of the origins of stellar flares on these stars.