TESS flares and chromospheric variability in three open clusters

FIKUT NEXTGEN
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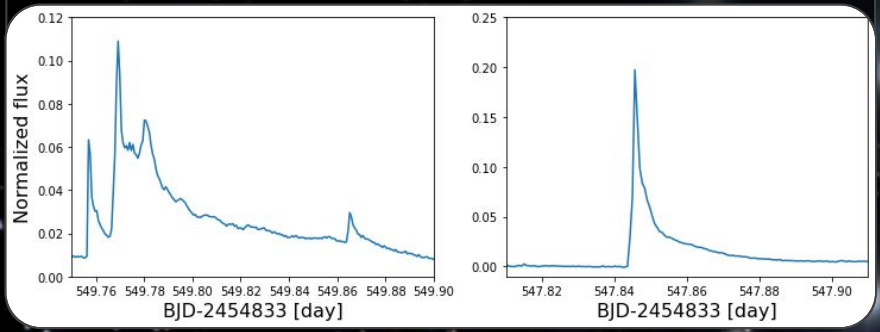
KONKOLY

HUN REN

CSFK

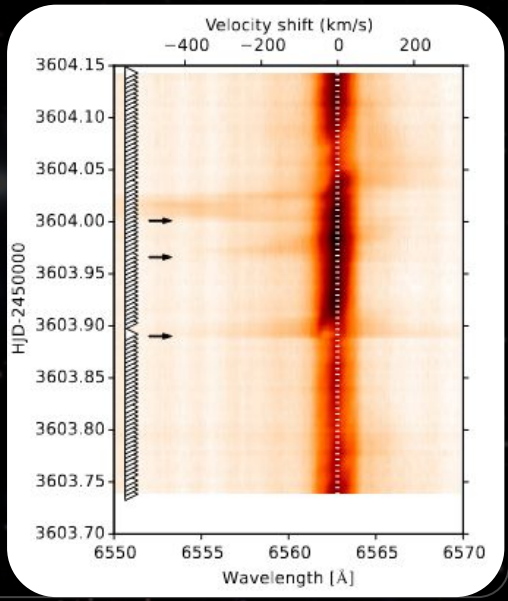
Flares

- Brightening caused by magnetic reconnection



Chromospheric activity

- CME
- Hα line variation



Vida et al. (2016)

How does it effect exoplanets?

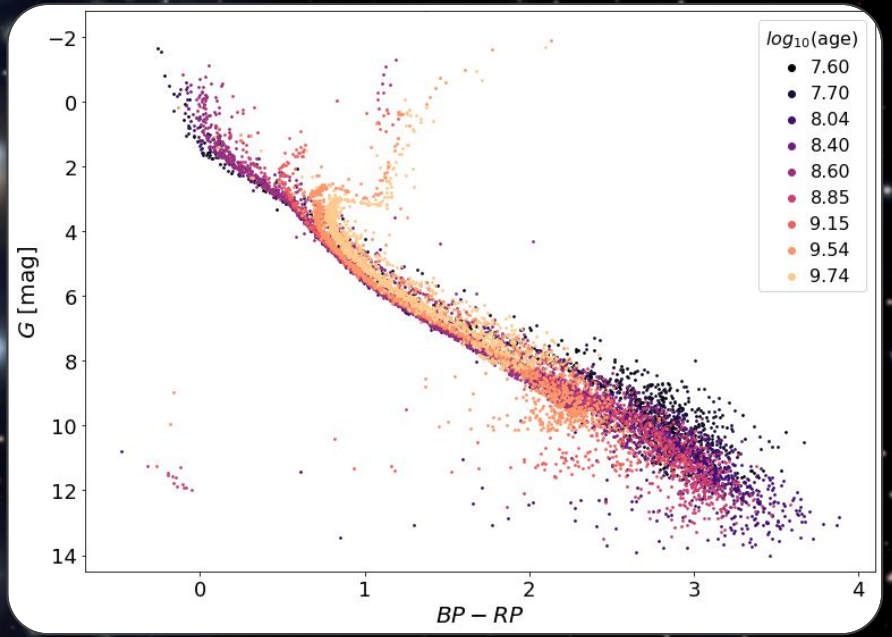
Open clusters

Cluster members:

- Similar age, metallicity
- Age well constrained

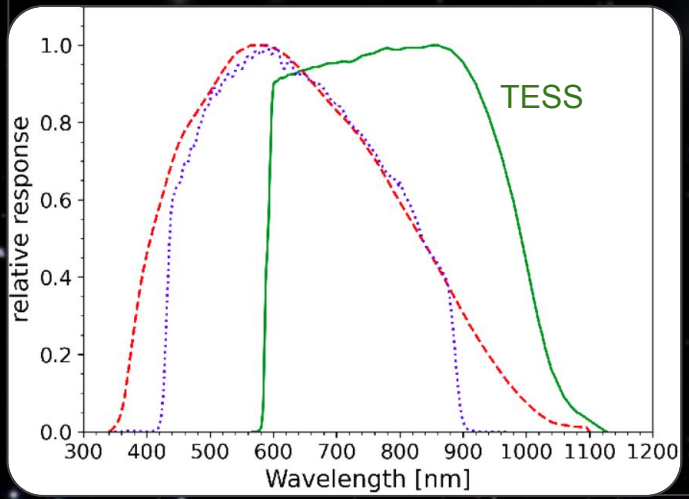
Activity evolution can be followed

Data from Gaia Collaboration et al. (2018)



TESS

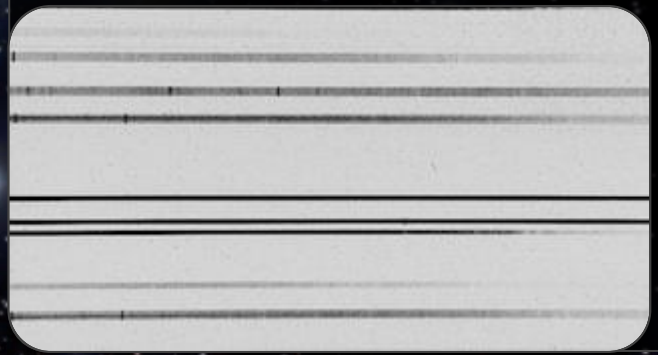
- 90°x24° field of view
- ~27 days sectors
- 20s, 120s, 600s cadences



Krenn et al. (2023)

OSMOS/MDM

- Multi object spectrograph
- Multiple cluster members can be observed at the same time
- 600-900 nm

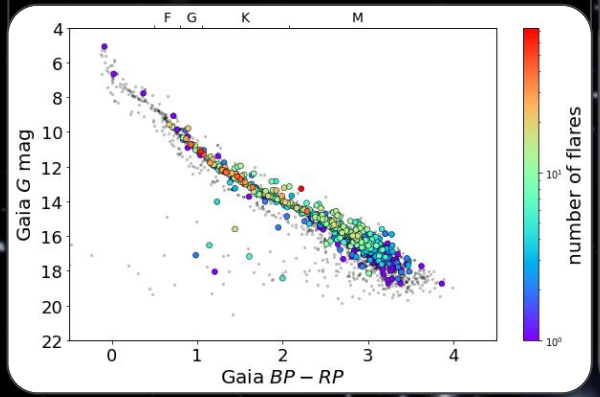


Multi-slit spectra with OSMOS

Target open clusters

Pleiades

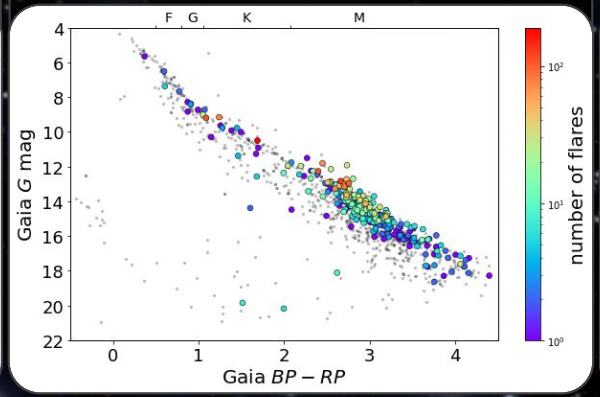
- 100 Myr
- 135.6 pc



Age: Netopil et al. (2016)
Distance: Cantat-Gaudin et al. (2018)

Hyades

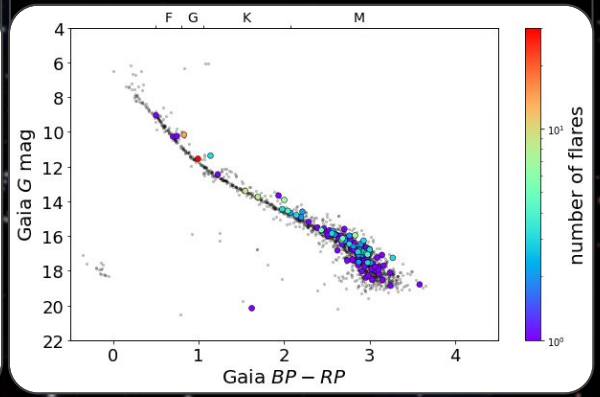
- 700 Myr
- 46.3 pc



Age: Netopil et al. (2016)
Distance: Perryman et al. (1998)

Praesepe

- 700 Myr
- 185.5 pc



Age: Netopil et al. (2016)
Distance: Cantat-Gaudin et al. (2018)

Flare identification and flare energy

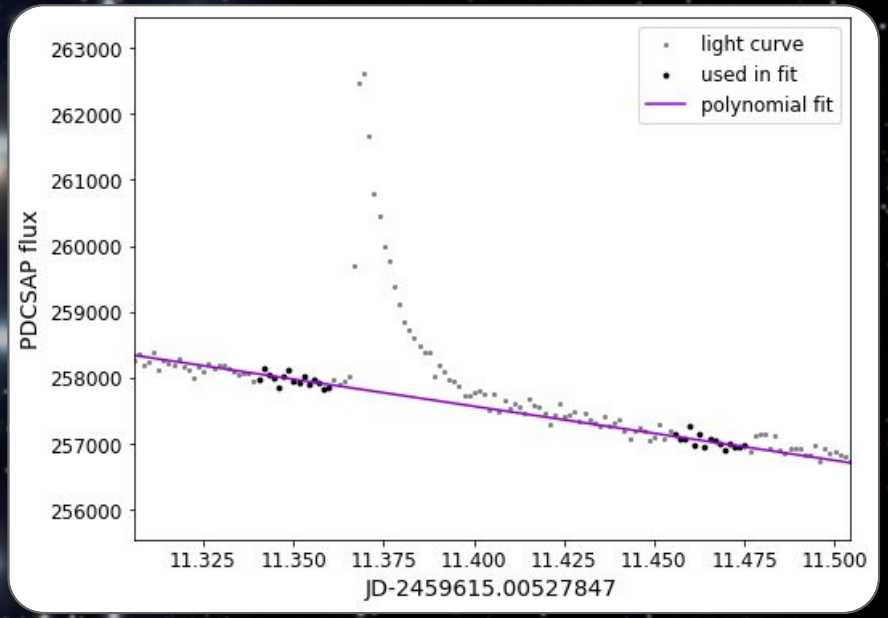
- Flare identification by eye

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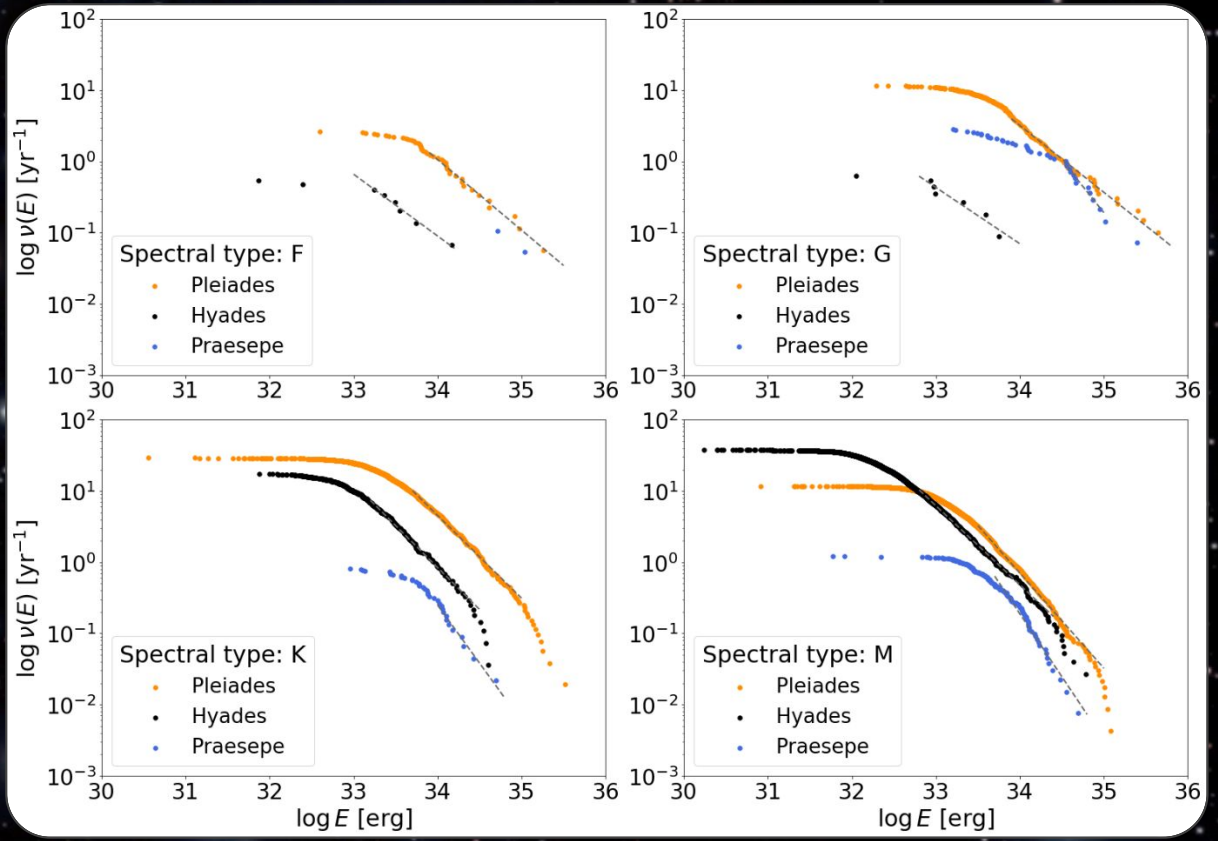
- Baseline removal
- Equivalent duration calculation
- TESS luminosity

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$$E_{\mathrm{TESS}} = L_{\mathrm{TESS}} \times ED$$

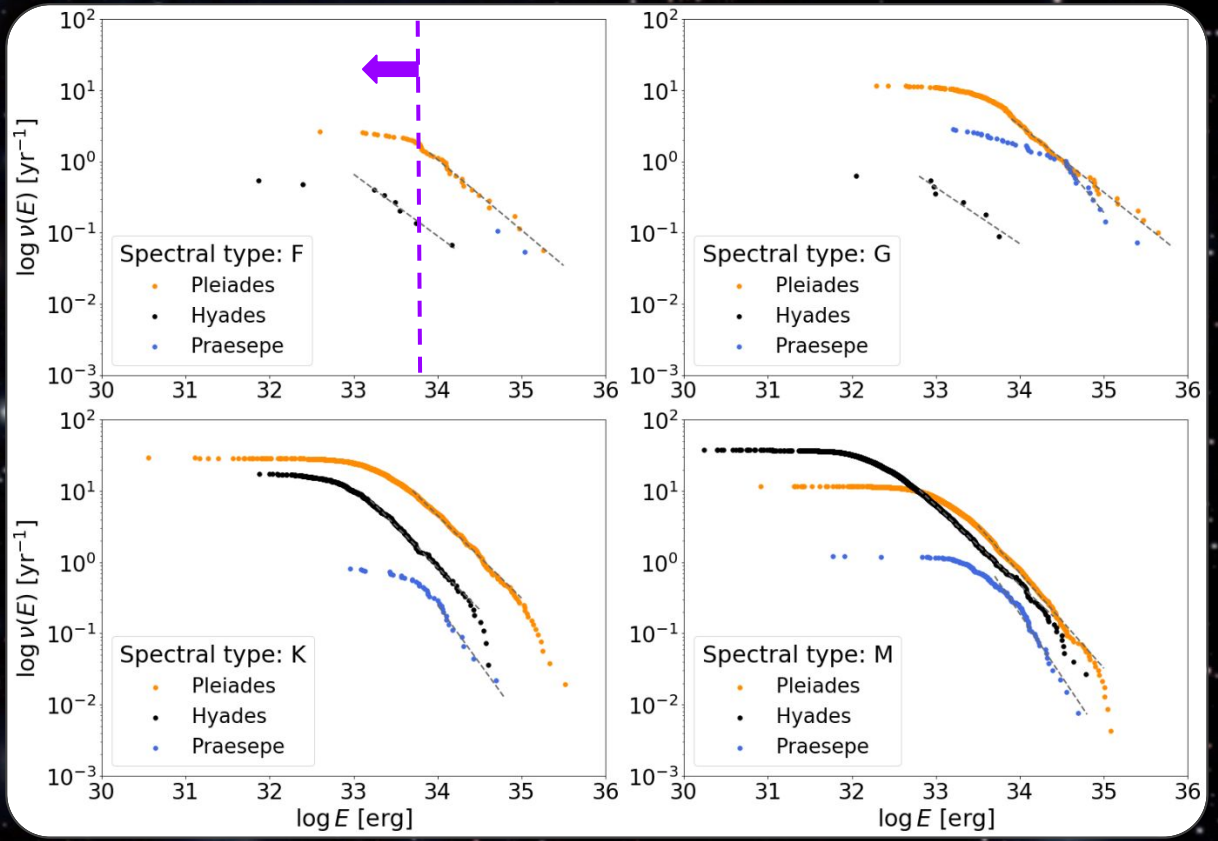


Flares of stars with different spectral types



Flares of stars with different spectral types

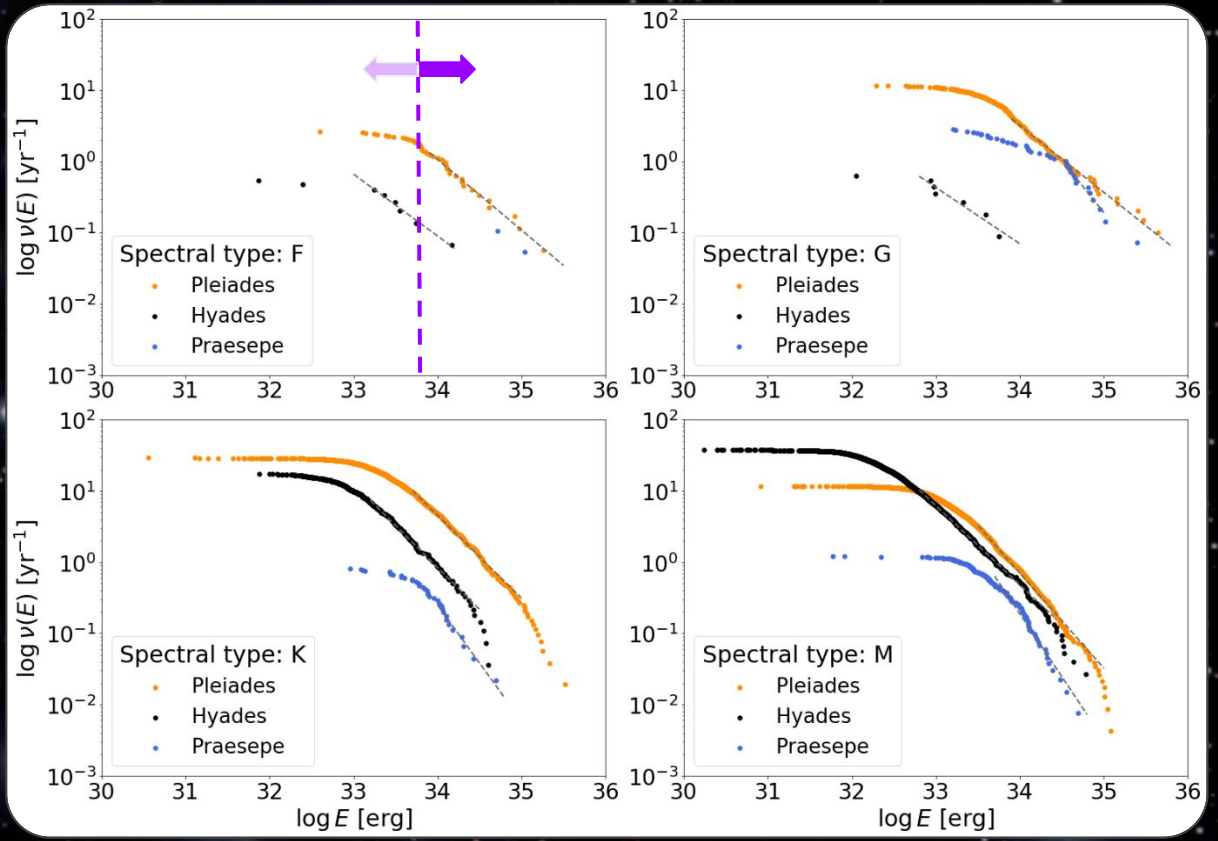
- Low energy flares invisible due to noise



Flares of stars with different spectral types

- Low energy flares invisible due to noise
- Power law distribution

Power law index

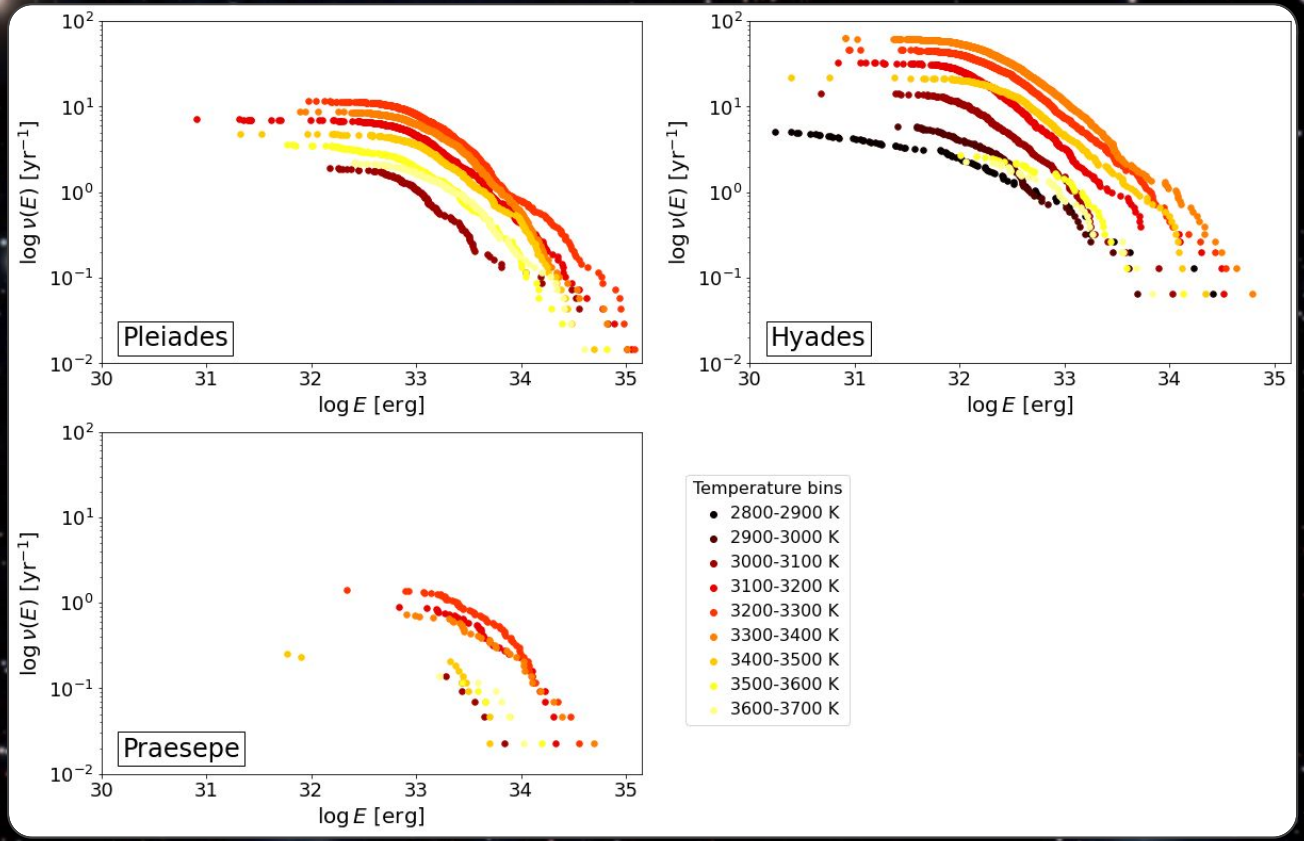


Flare activity changes with effective temperature for M dwarfs

- Flare rates in 100 K temperature bins

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- Flare rate maximum at ~3200 K effective surface temperature

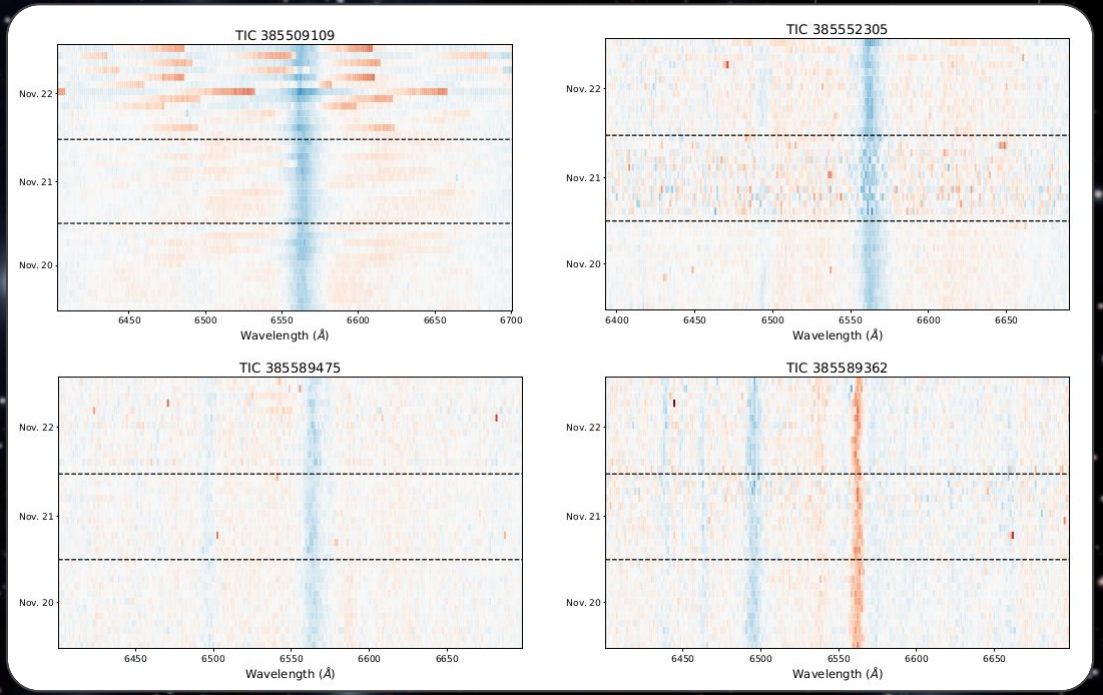


Dynamic spectra

Pleiades Hα:
- 3 absorption
- 1 emission

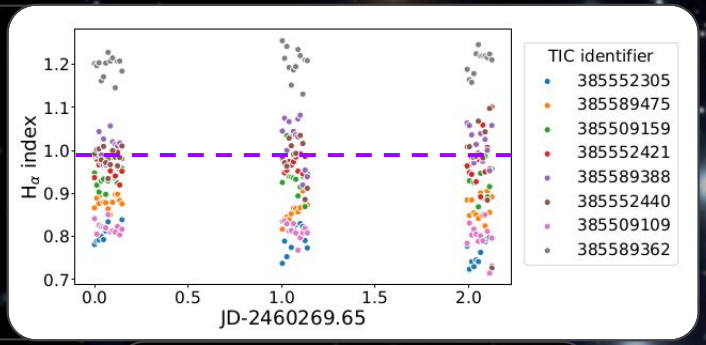
Praesepe Hα:
- 3 absorption
- 2 emission

Pleiades



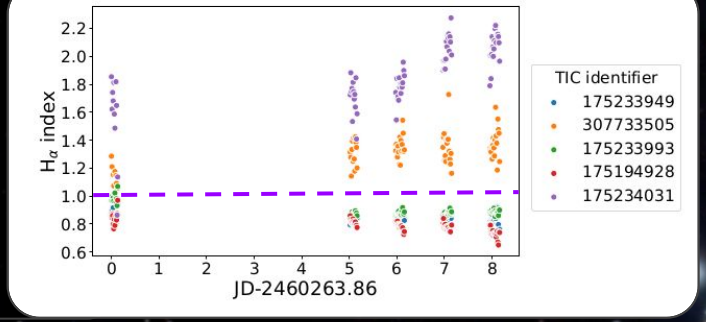
Variations of the Hα line

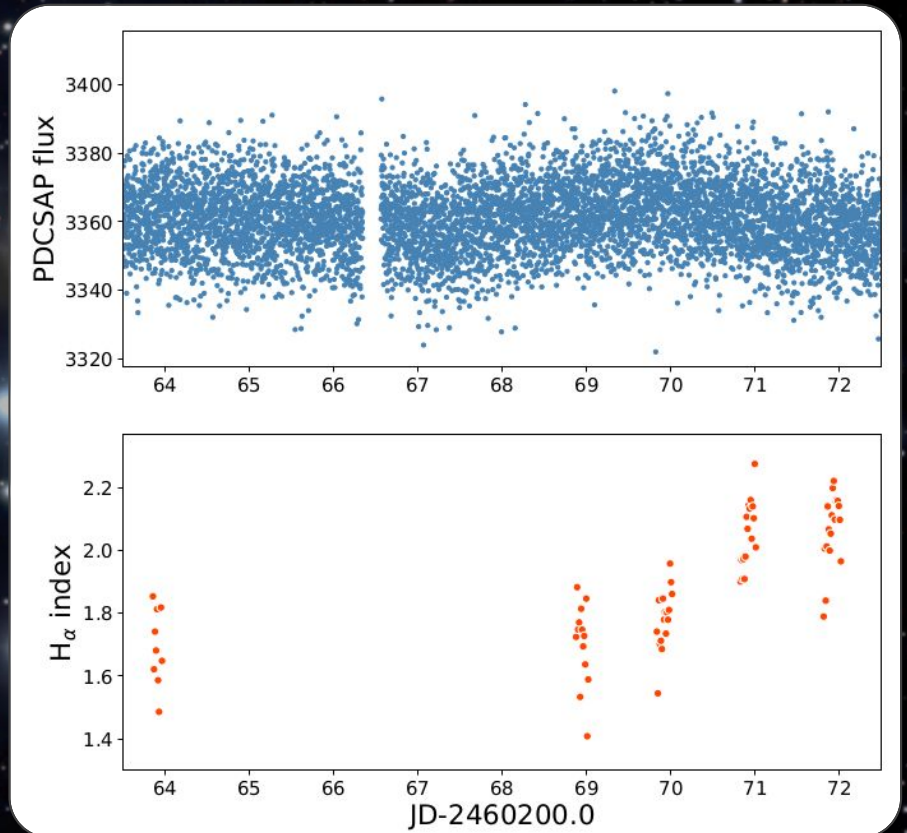
Pleiades



$$I_{\mathrm{H}\alpha} = \frac{\overline{F}_{\mathrm{H}\alpha}}{0.5 \cdot (\overline{F}_1 + \overline{F}_2)}$$

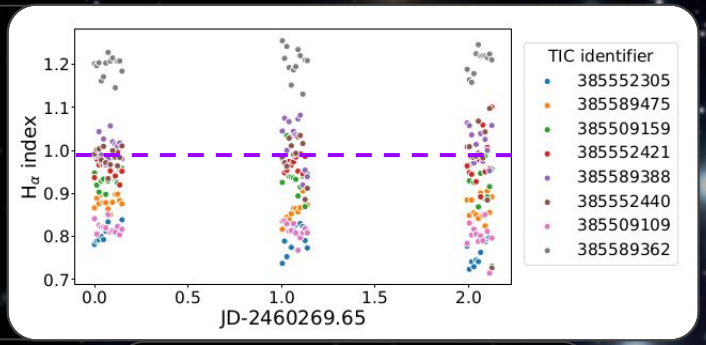
Praesepe





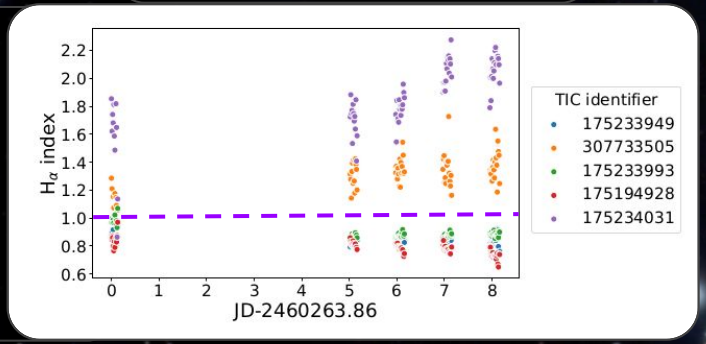
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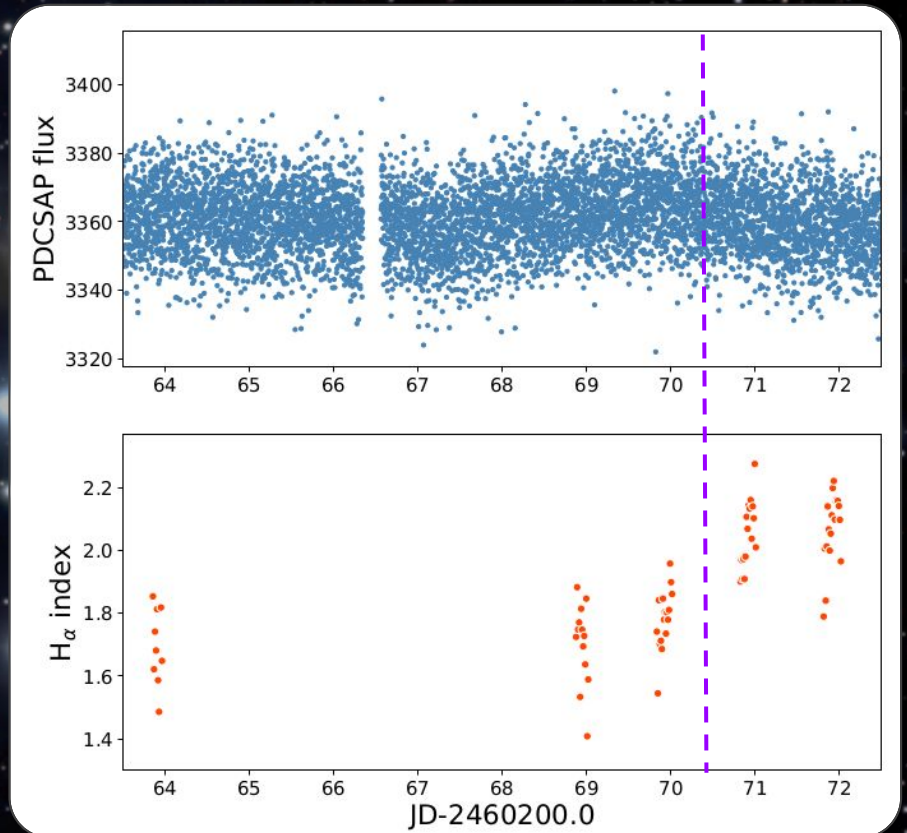
Pleiades



$$I_{\mathrm{H}\alpha} = \frac{\overline{F}_{\mathrm{H}\alpha}}{0.5 \cdot (\overline{F}_1 + \overline{F}_2)}$$

Praesepe





CME statistic

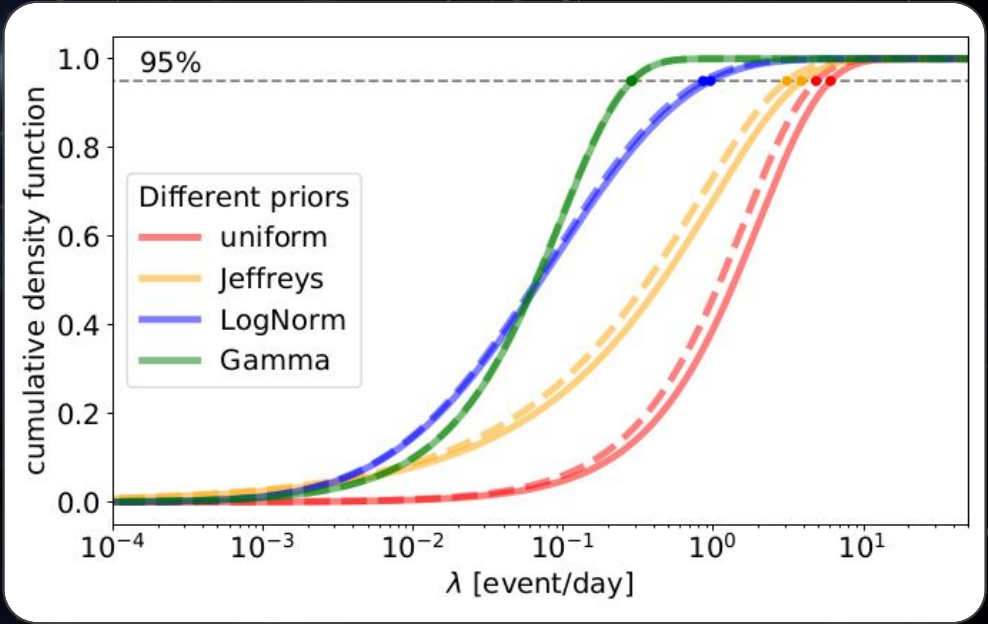
- 4 different priors
- Flare frequency distributions from TESS

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95% credible upper limit on the < 0.3 − 6 / day CME rate

Pleiades

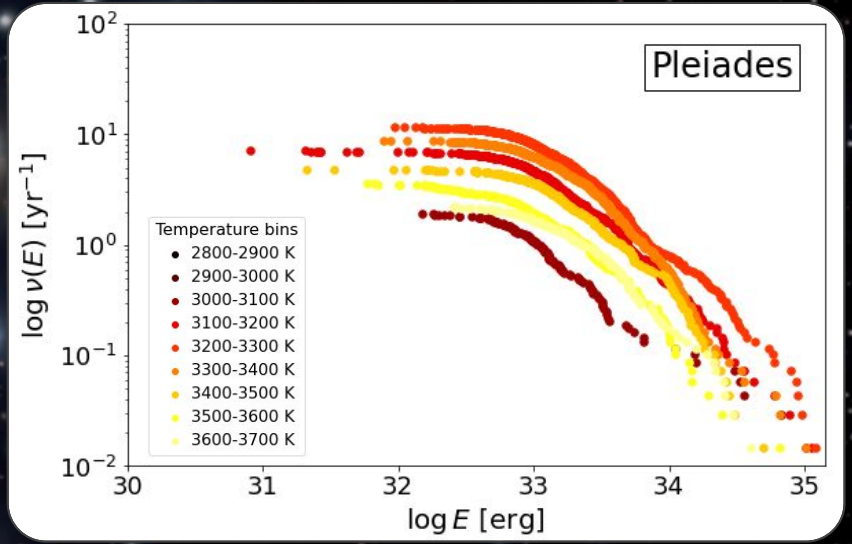
Praesepe



Summary

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- Flares in Pleiades, Hyades and Praesepe from TESS
- Dynamic sectra for Pleiades and Praesepe stars
- Flare rate maximum at ~3200 K effective surface temperature
- CME rate < 0.3 − 6 / day



Thank you for your attention!