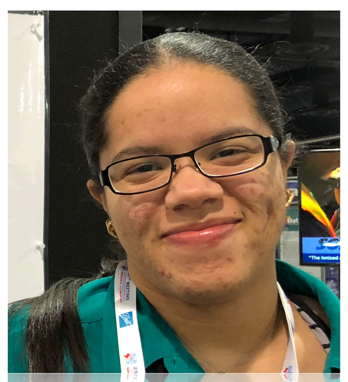
Contemporaneous Observations of Hα Luminosities and Photometric Amplitudes for M dwarfs



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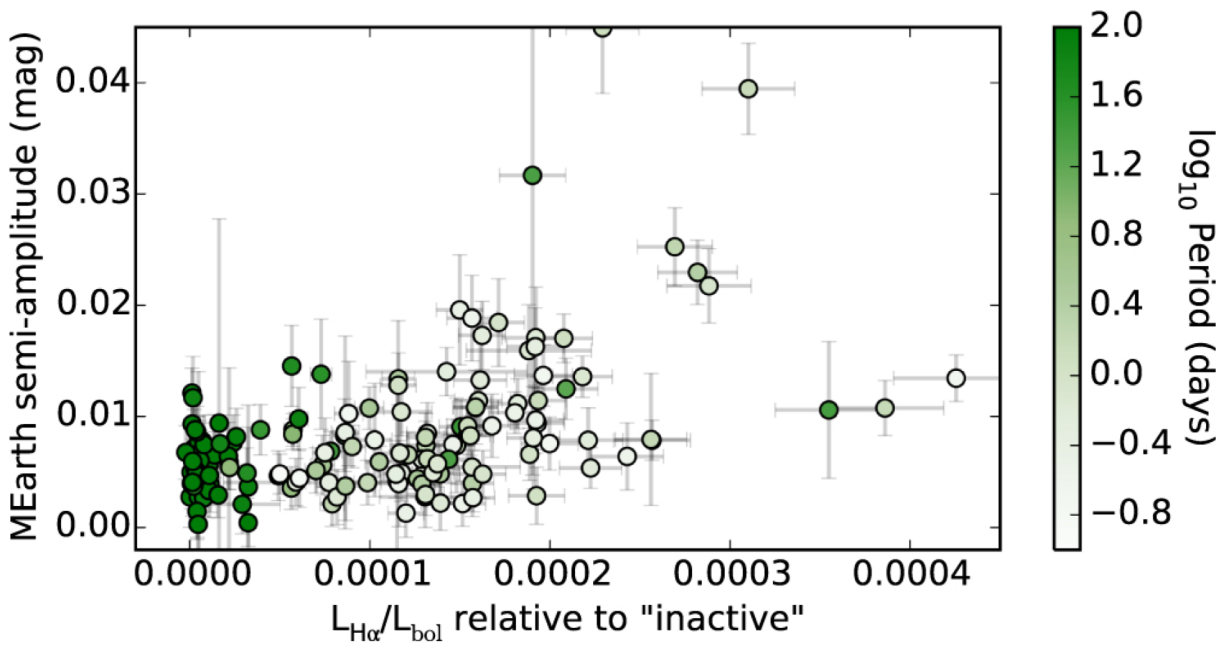
Does a relationship between $L_{H\alpha}/L_{bol}$ and Photometric variability exist?

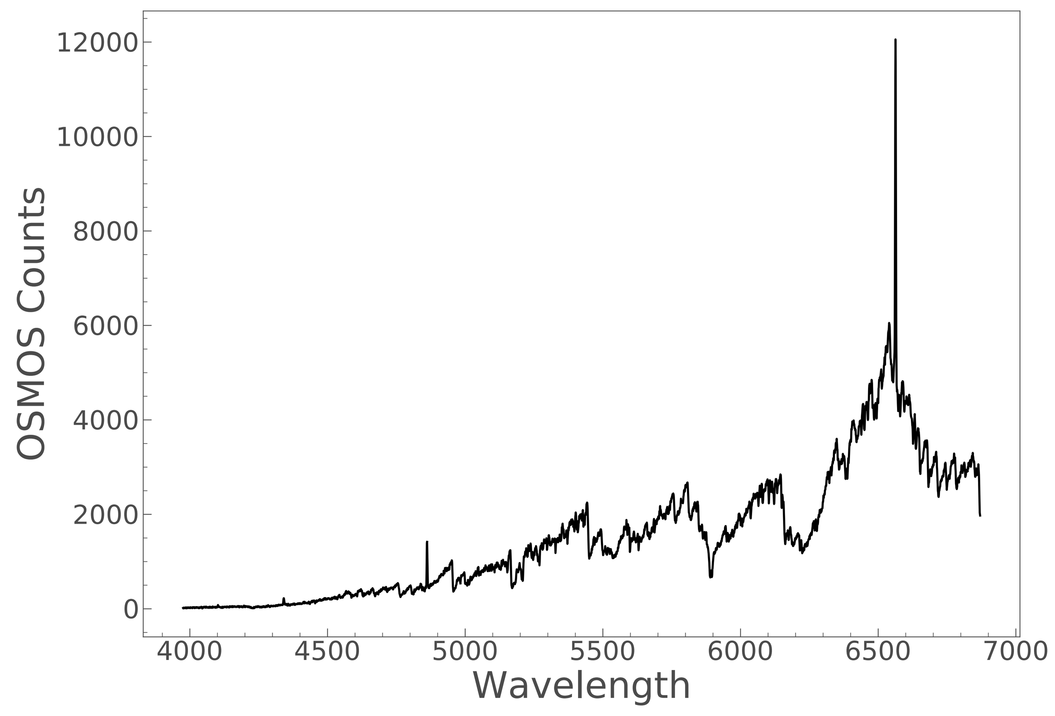


- Newton+17 noted a positive correlation between photometric amplitude and $L_{H\alpha}/L_{bol}$ for mid-to-late M dwarfs ($P_{rot} < 200$ days; the Northern Hemisphere).
- They concluded the experiment could benefit from considering non-sinusoidal rotational variability and spot evolution.

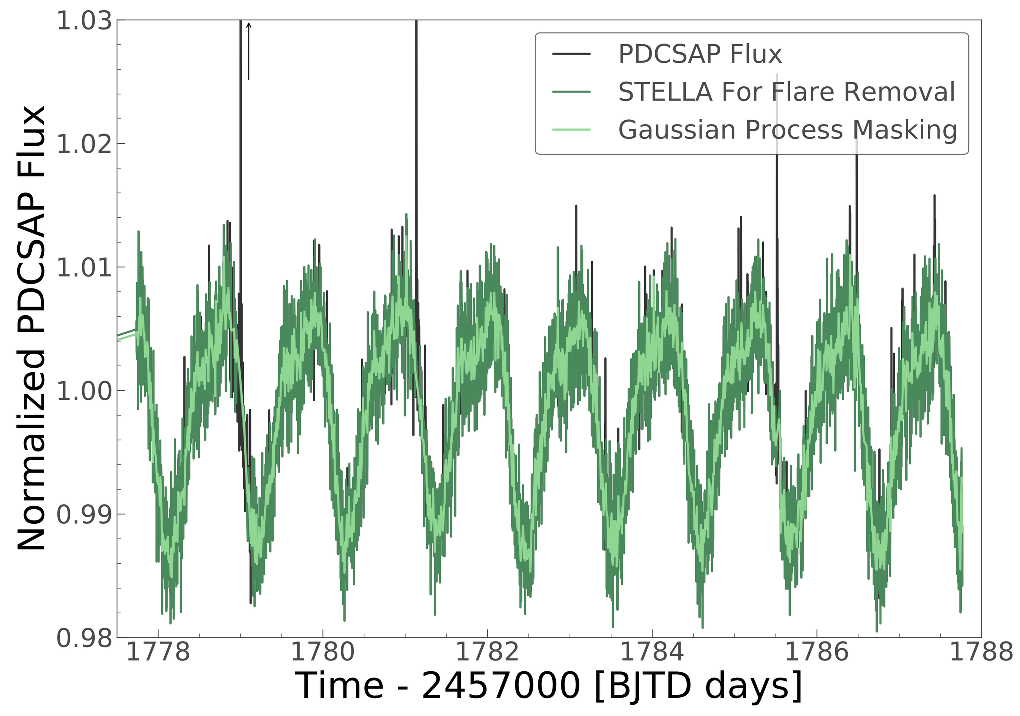
We selected M dwarfs in the Northern Hemisphere with existing Rotation Periods and $v \sin i$

- Cross-correlate three M dwarf catalogs with $v \sin i$: Fouqué+18, Reiners+18 and Kesseli+18 against Newton+16,17.
- Other Constraints:
  - V magnitude ($V < 17.5$)
  - $P_{rot} < 27$ d (TESS sector length; Ricker+15)
- Merged catalog 133 targets:
  - Observed 65 with MDM 2.4m Ohio State Multi-Object Spectrograph (OSMOS; Martini+11)
    - Multiple observations for 22.
    - **Final sample:** 56 were observed close in time by TESS.

We obtained low-resolution optical spectra contemporaneously with optical photometry from TESS.



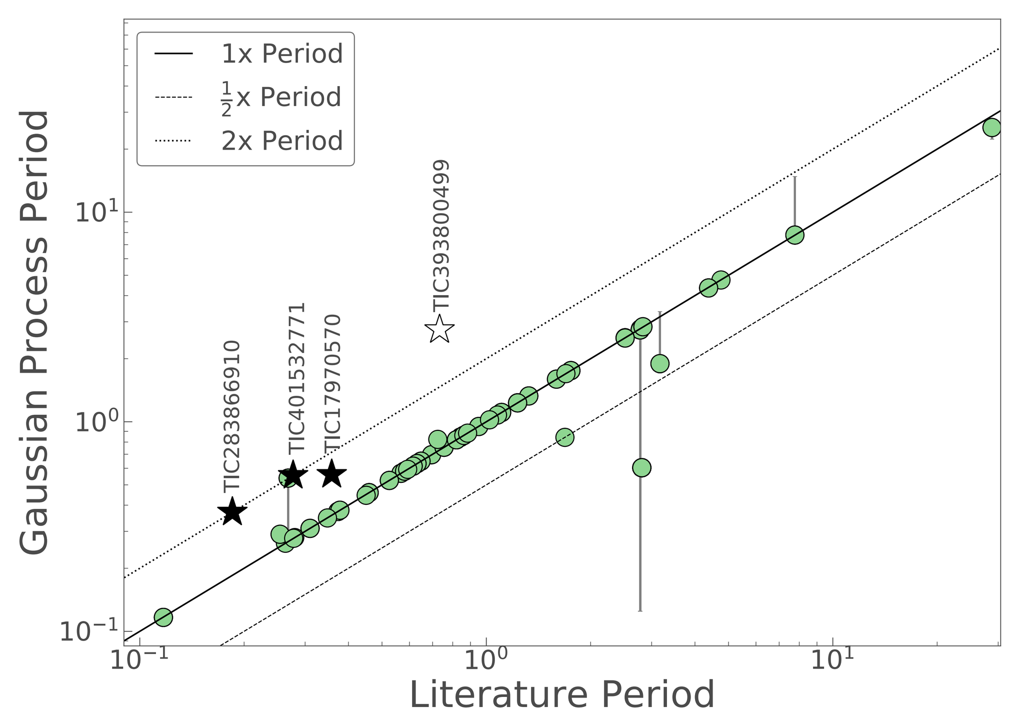
- We obtained low-resolution optical spectra using the OSMOS.
- An example spectrum shows strong emission at $H\alpha$, due to magnetic heating of the stellar atmosphere.



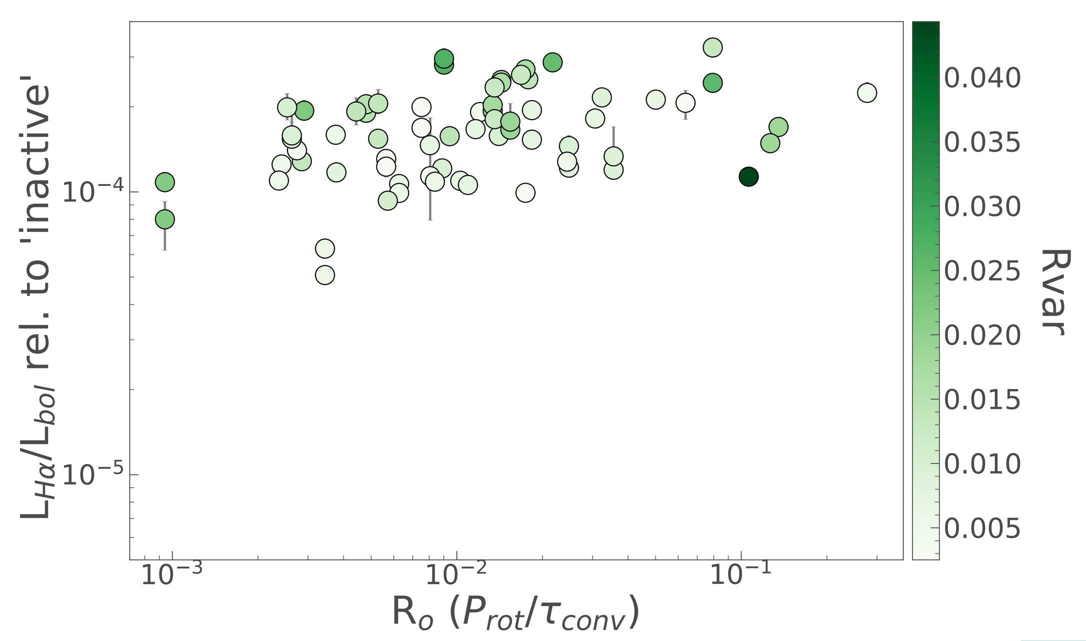
- Active stars can produce frequent flares which we remove to get amplitude:

1. Use Feinstein+20a,b's *stella* which trains a CNN using TESS light curves (LC).
2. Bin to 10 minutes
3. Fit a Gaussian process model to the data, masking additional outliers.

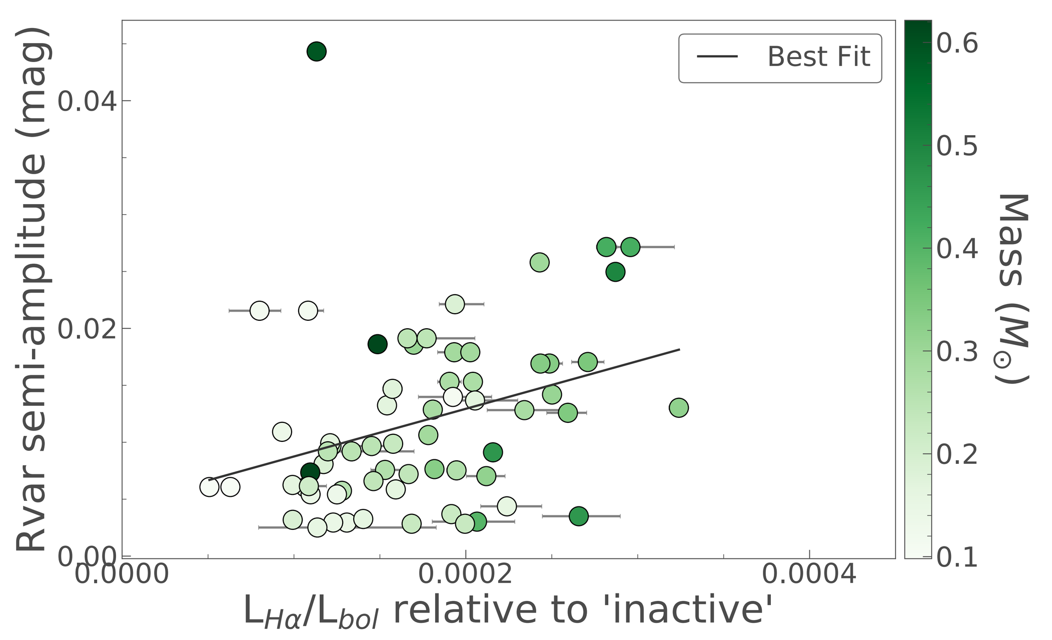
A Scattered Relationship between $L_{H\alpha}/L_{bol}$ and Photometric Variability for M dwarfs in the Saturated Regime exists!



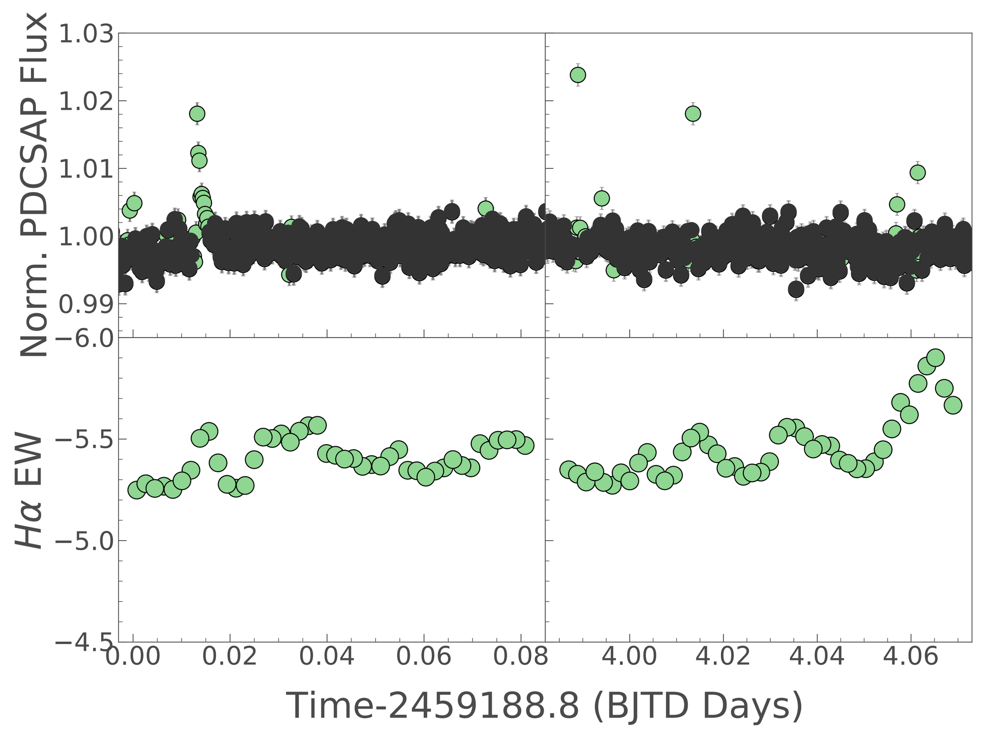
- Periods using Gaussian processes.
- We estimate newer periods:
  - ☆ - The literature period is an alias of the true period.
  - ★ - The literature period is double the true period.



- Rotation-activity plot for stars in our sample
  - The Rossby number (rotational period over convective overturn) is defined in Wright+18.
  - The stars are all on the saturated regime.



- Rvar (McQuillan+12,13; $0.5 \times (95^{th}\ \% - 5^{th}\ \%)$)
- The x-axis error bars are range of $H\alpha$ EWs.
- Although the data is contemporaneous, the significant scatter is real. This is maybe because the magnetic field proxies measure different processes.



- Top panels show portions of the TESS LCs, while the bottom panels show contemporaneous $H\alpha$ EW time-series.
- Like Kruse+10, Lee+10 and Medina+22, EWs vary on timescales less than an hour.
- Evidence of flare enhancement BJTD 2459188.800 — 2459188.825.

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