SHORT-TERM STELLAR ACTIVITY ANALYSIS OF THE ARIEL DRY RUN'S TARGETS

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OUTLINE

- Introduction to flare and light curve analysis
- Methods
- Results for each star

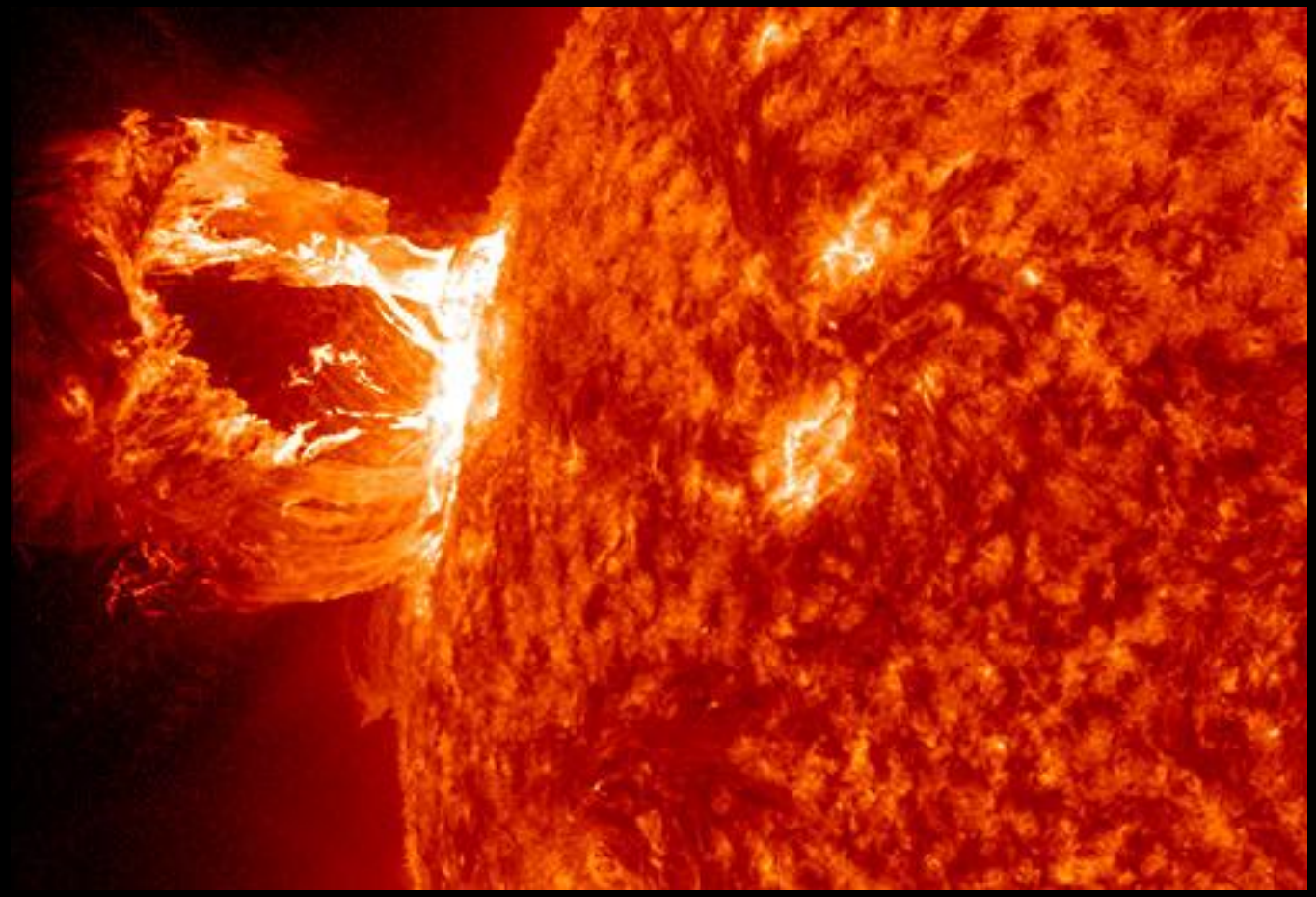
INTRODUCTION

FLARE

STELLAR VARIABILITY

STELLAR WIND

Exoplanetary Atmospheres



OBJECTIVE

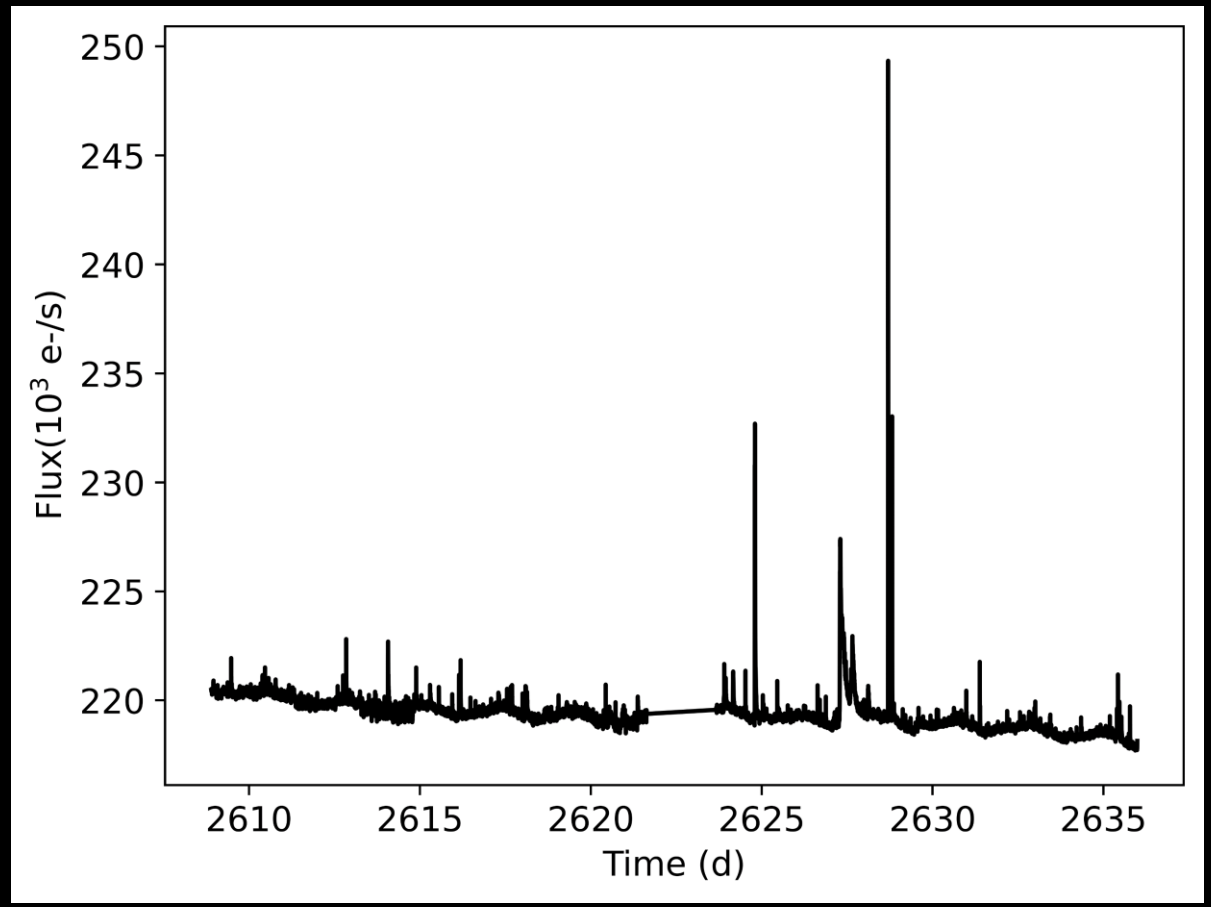
- Identifying impulsive events in TESS light curves for the Ariel dry run's target using the methodology proposed by Colombo et al. (2022).

- Determine flare frequency and compare them with each other.

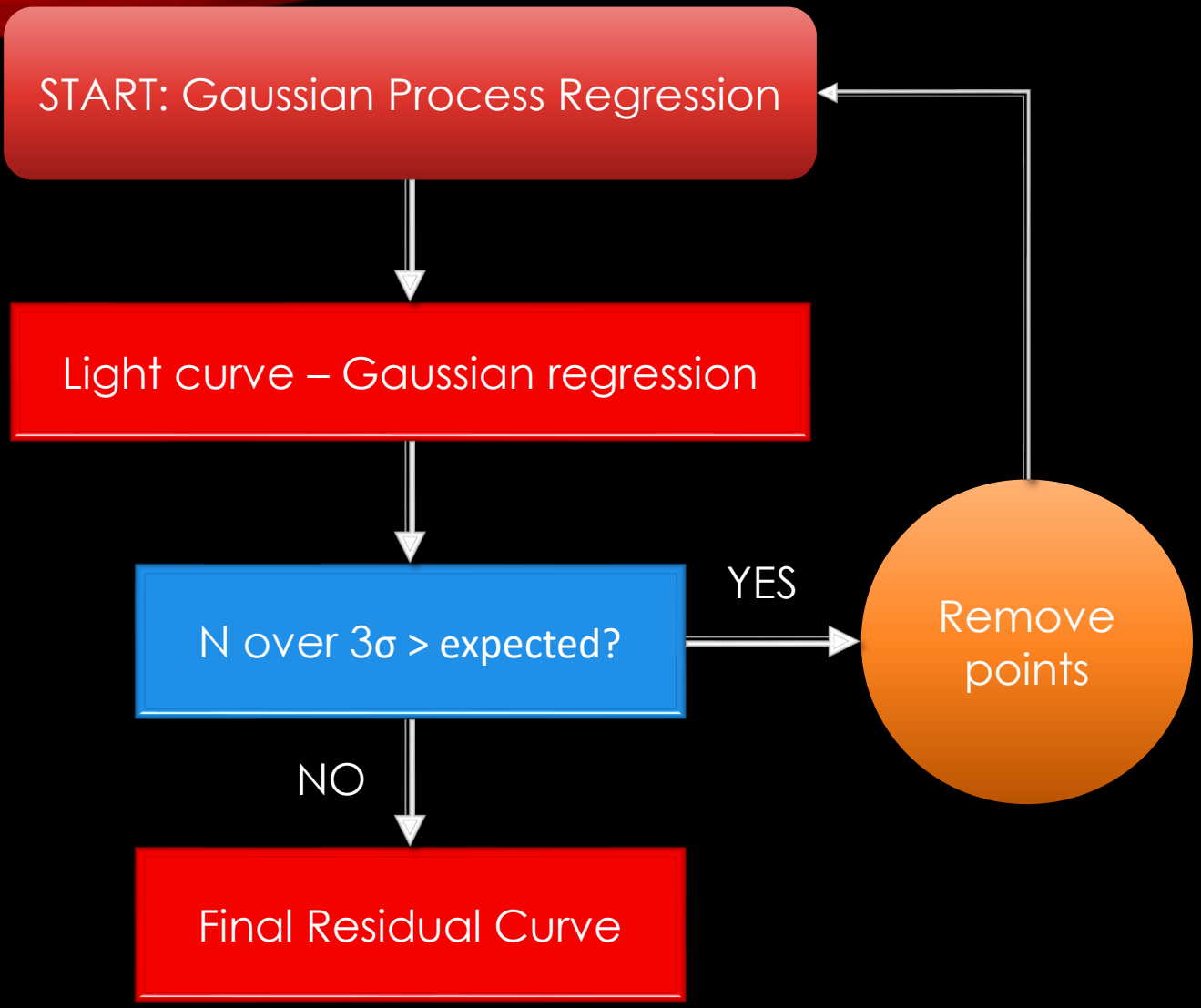
This tool aims to be simple and effective in studying short-term stellar activity, using only the star's light curve to derive the distribution and energy of flares.

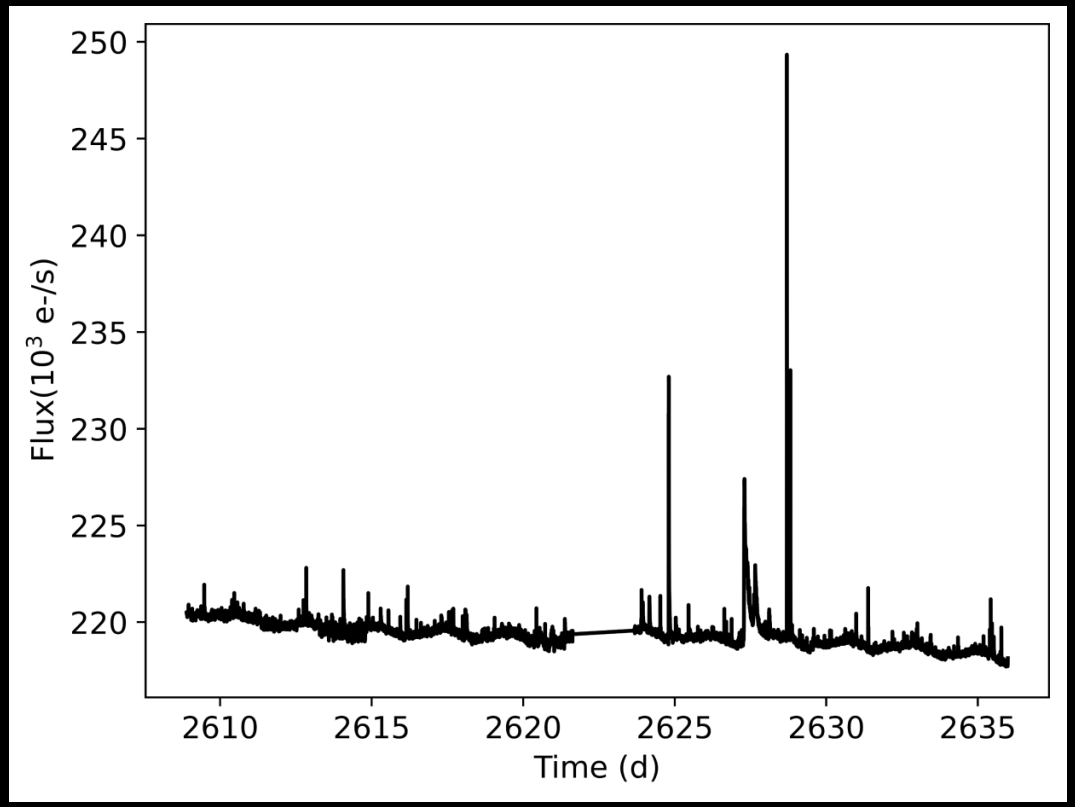
TESS

- **TESS** (Transiting Exoplanet Survey Satellite): a space telescope to detect exoplanets through transit on bright stars.
- TESS is more efficient compared to previous missions.
- **High temporal cadence**
- **Long time baseline**



METHODS


START: Gaussian Process Regression
Light curve – Gaussian regression
N over 3σ > expected?
YES
Remove points
NO
Final Residual Curve


250
245
240
235
230
225
220
Flux(10³ e-/s)
2610
2615
2620
2625
2630
2635
Time (d)

METHODS

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Light curve – Gaussian regression

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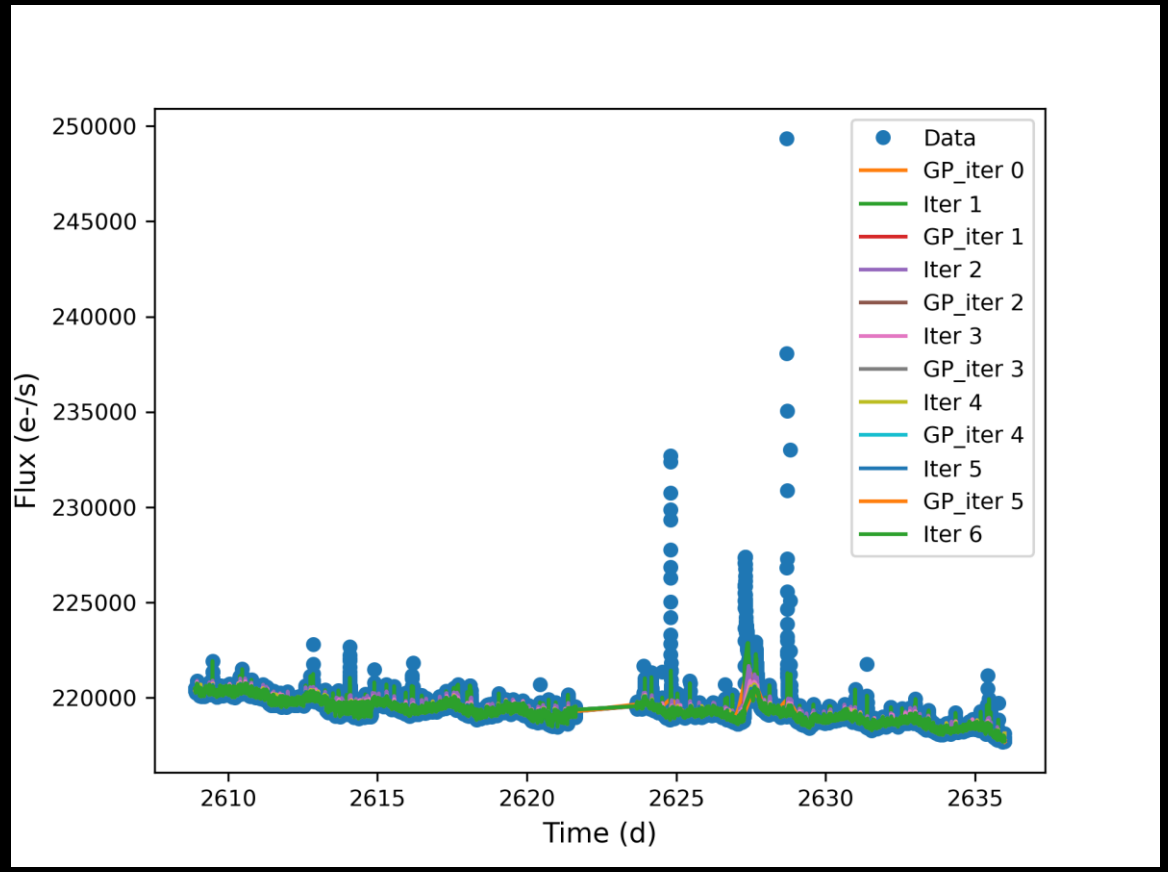

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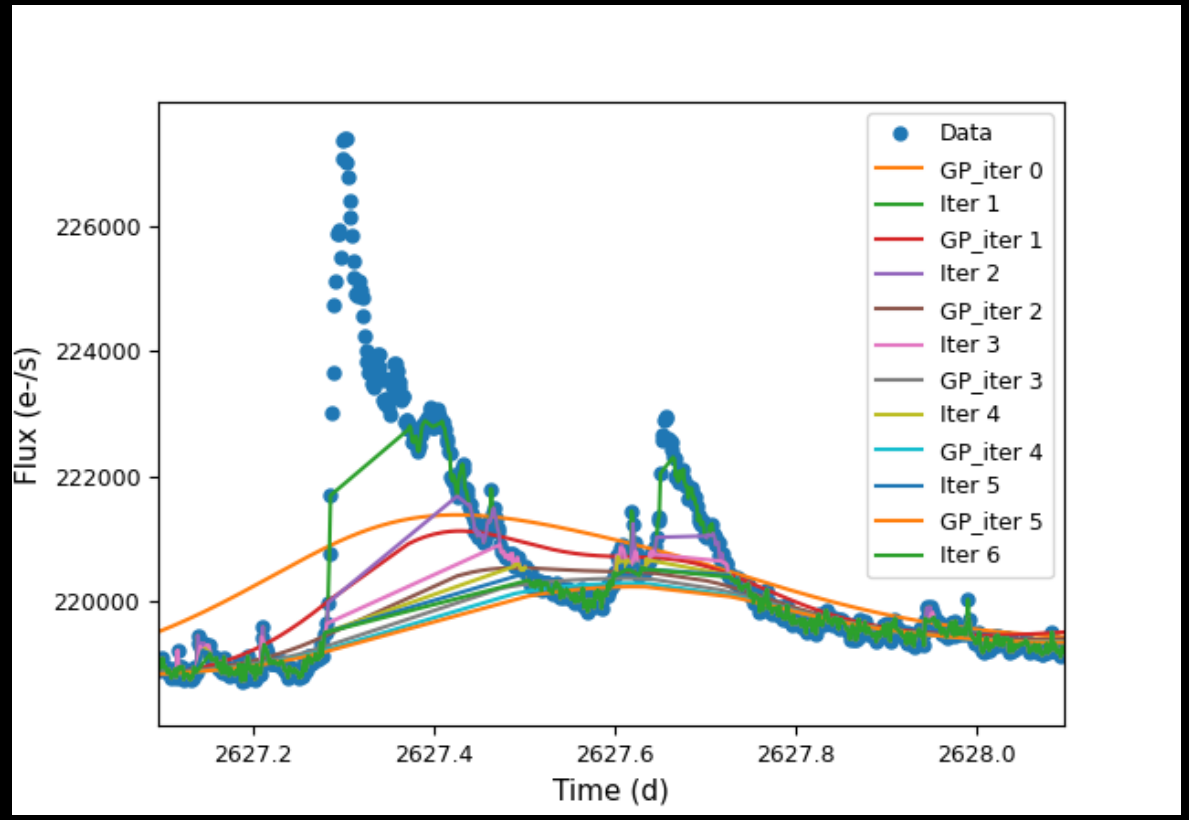

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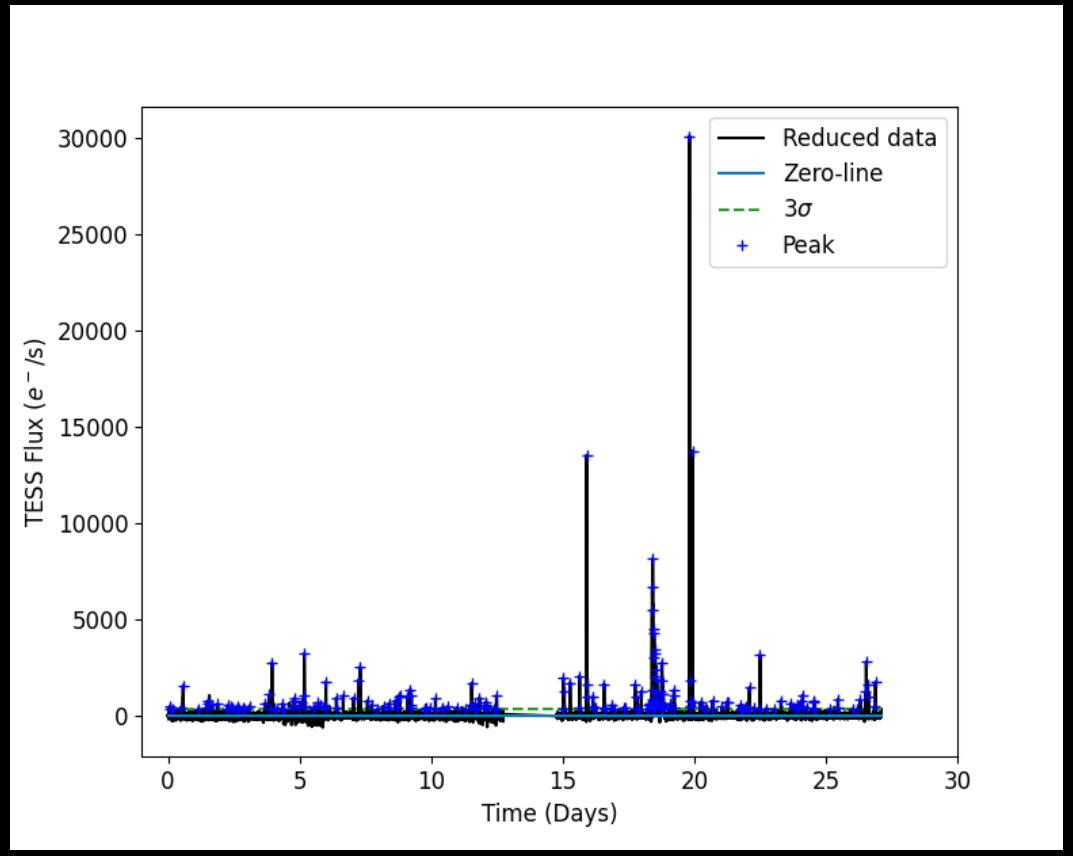


METHODS

Maximum Peak identification

Impulsive event fit

Is τ_d> 50s?

NO

Event discarded

YES

Event acquired

Fit substraction from residual curve

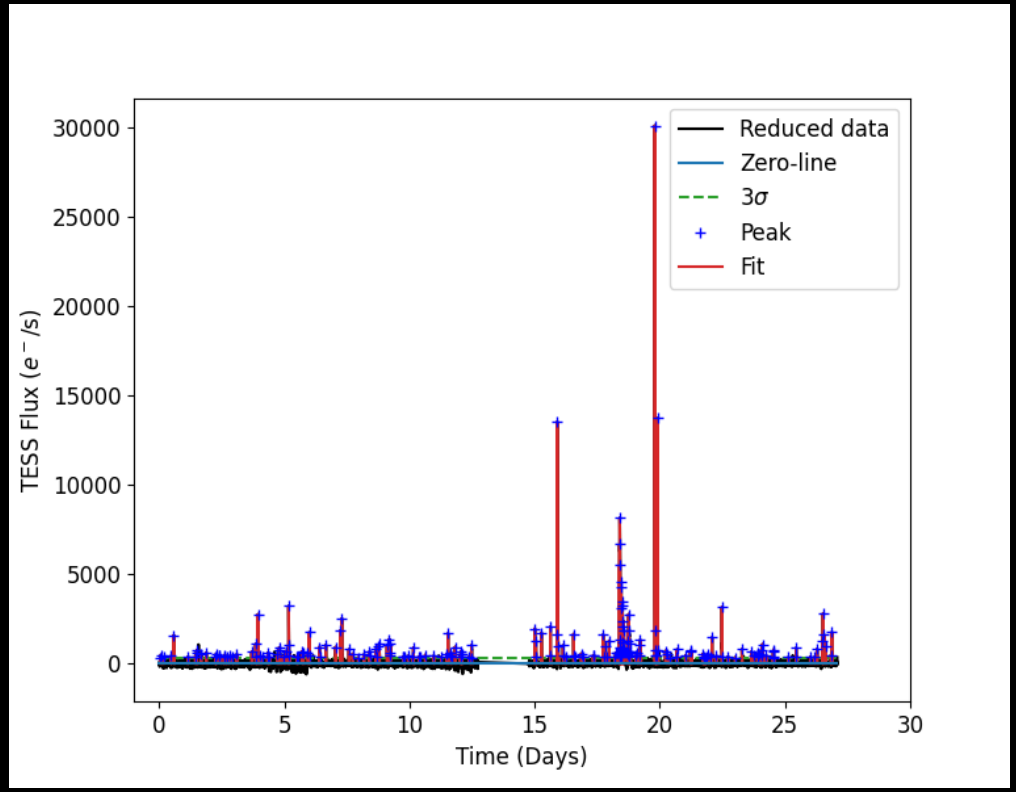
More peak over 3σ?

YES

Repeat

NO

END



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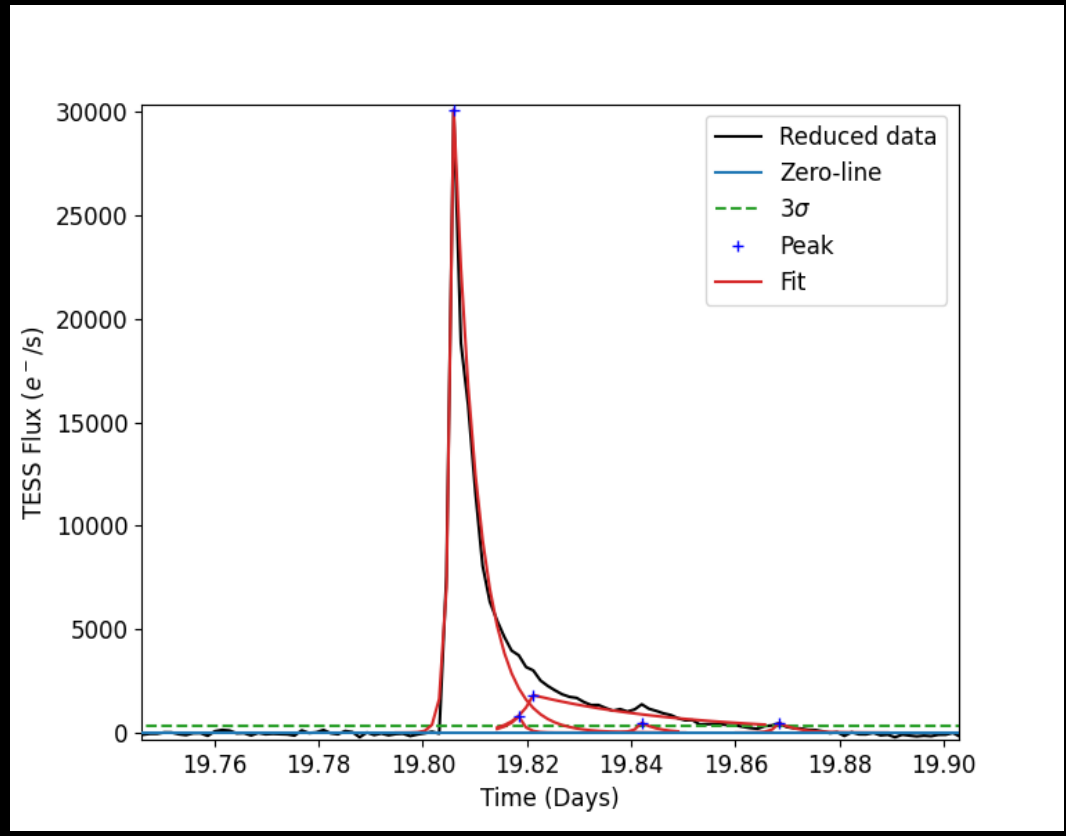


METHODS

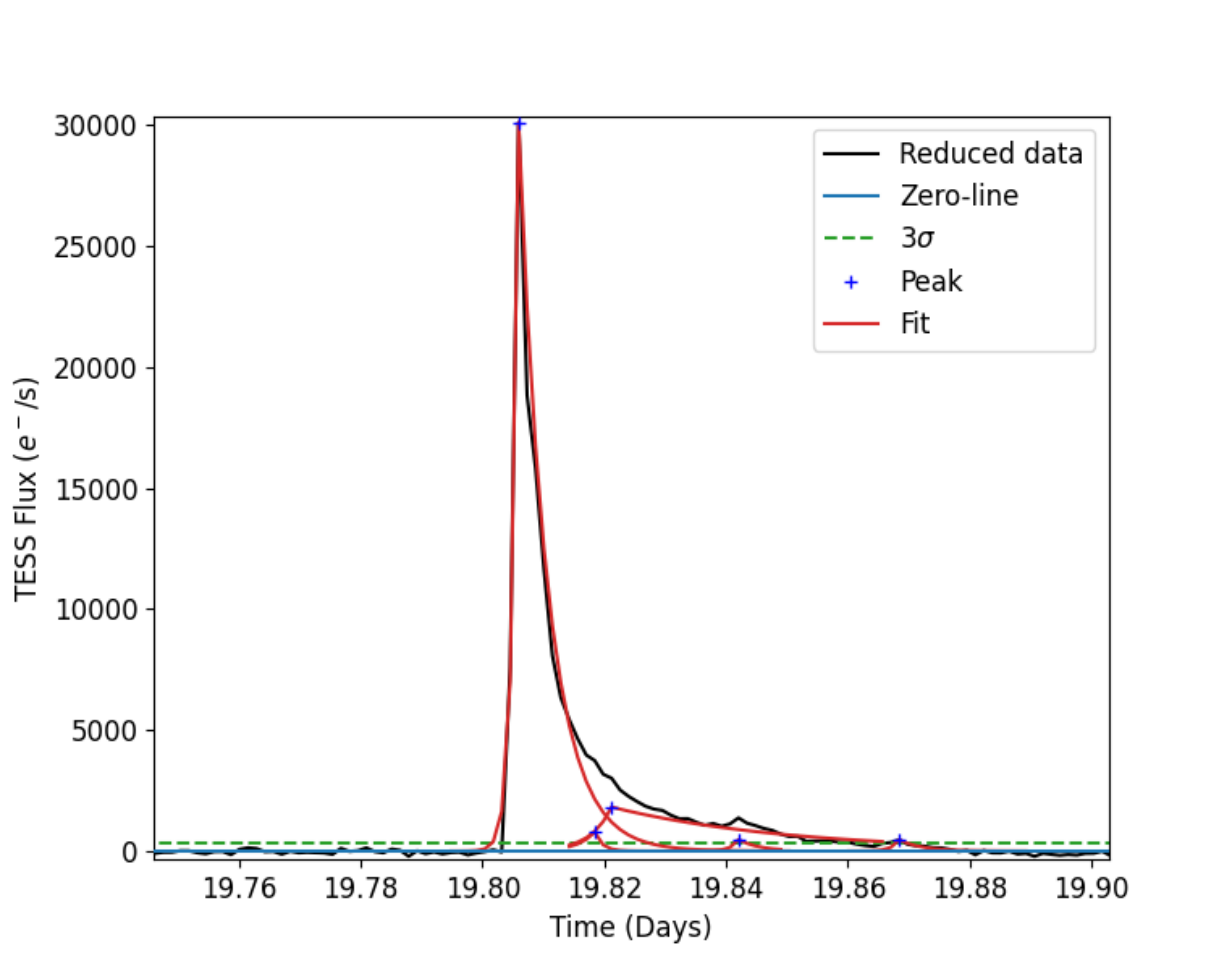
$$F(t) = H(t_0 - t) \cdot Ae^{\frac{t-t_0}{t_r}} + H(t - t_0) \cdot Ae^{\frac{t_0-t}{t_d}}$$

- **$H(t_0 - t)$:** The Heaviside function used to transition from the rising part to the decaying part of the function.
- **A:** The peak of the event.
- **t_r:** The rise time.
- **t_d:** The decay time.

Energy Estimation for Each Event:

$$E = (A \cdot t_r + A \cdot t_d)\frac{L_{bol}}{L_{TESS}}$$

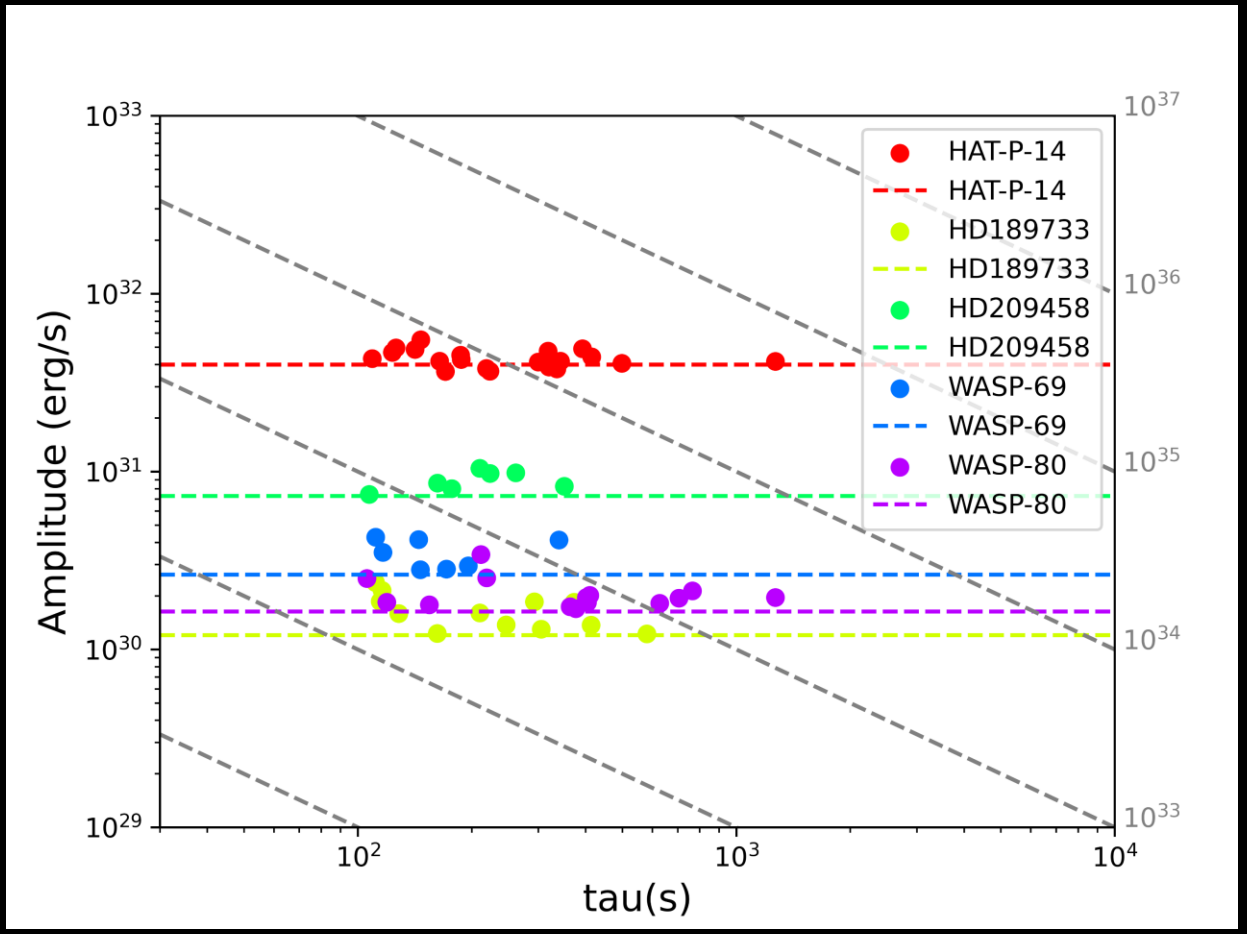
L_{bol} is the bolometric luminosity for each star.

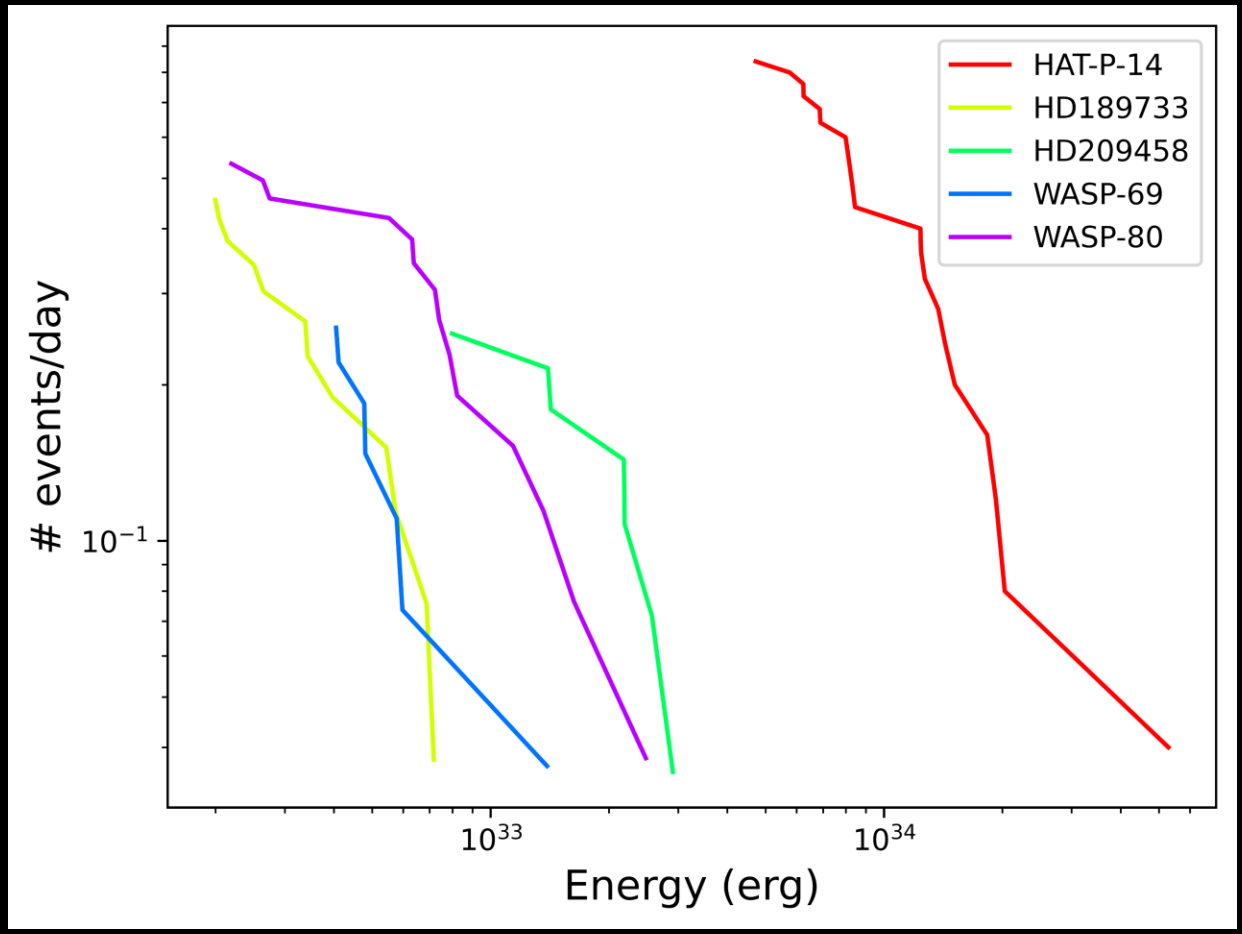


STAR	L_{bol} (this work)	Spectral type	TESS SECTORS
HAT-P-14	3.621 $L_{\odot}$	F5V	25 26 52 53
HD 189733	0.3618 $L_{\odot}$	K2V	41 54
HD 209458	1.678 $L_{\odot}$	F9V	56
WASP-69	0.3473 $L_{\odot}$	K5V	55
WASP-80	0.09150 $L_{\odot}$	K7V-M0V	54

RESULTS

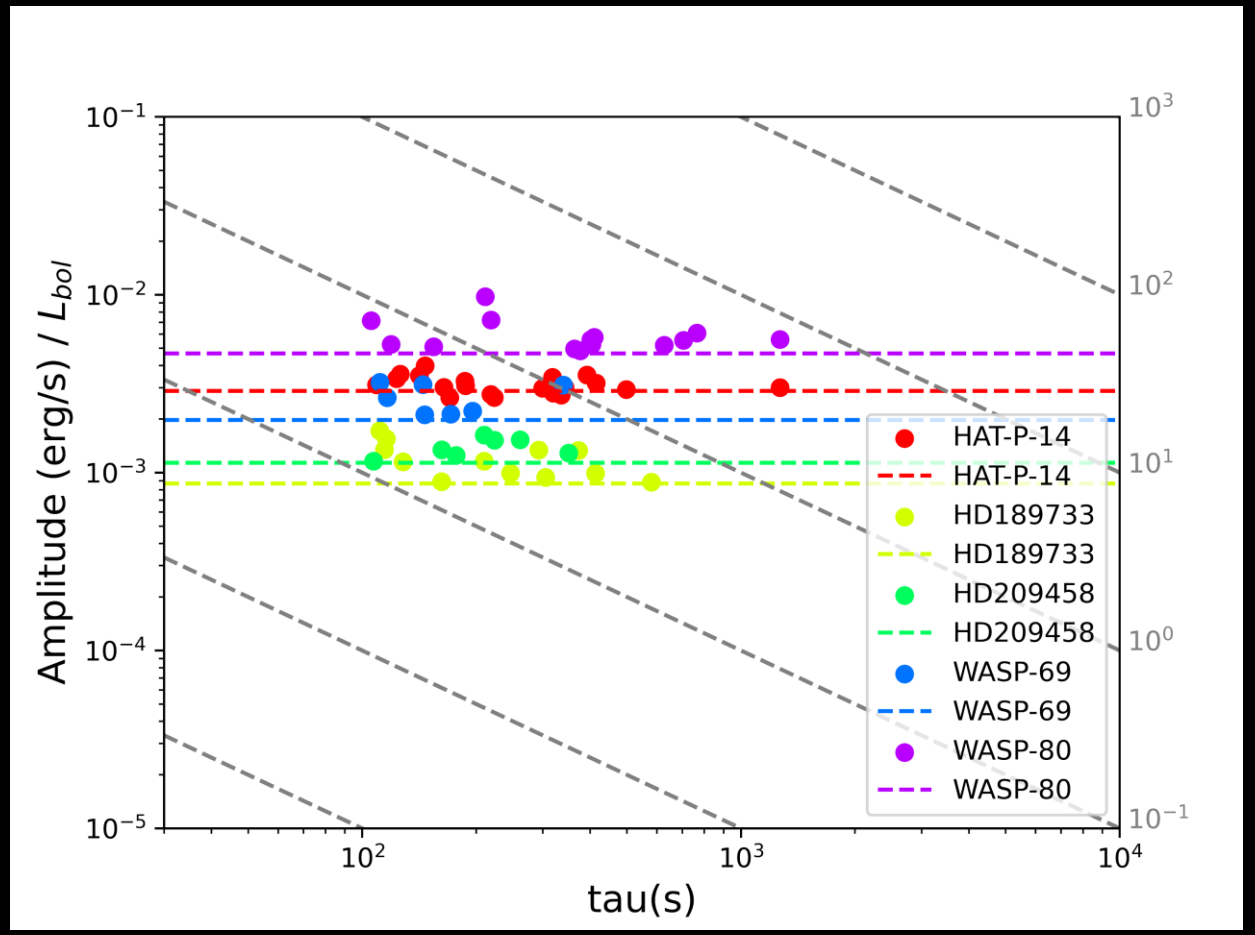
Cumulative energy frequency distribution

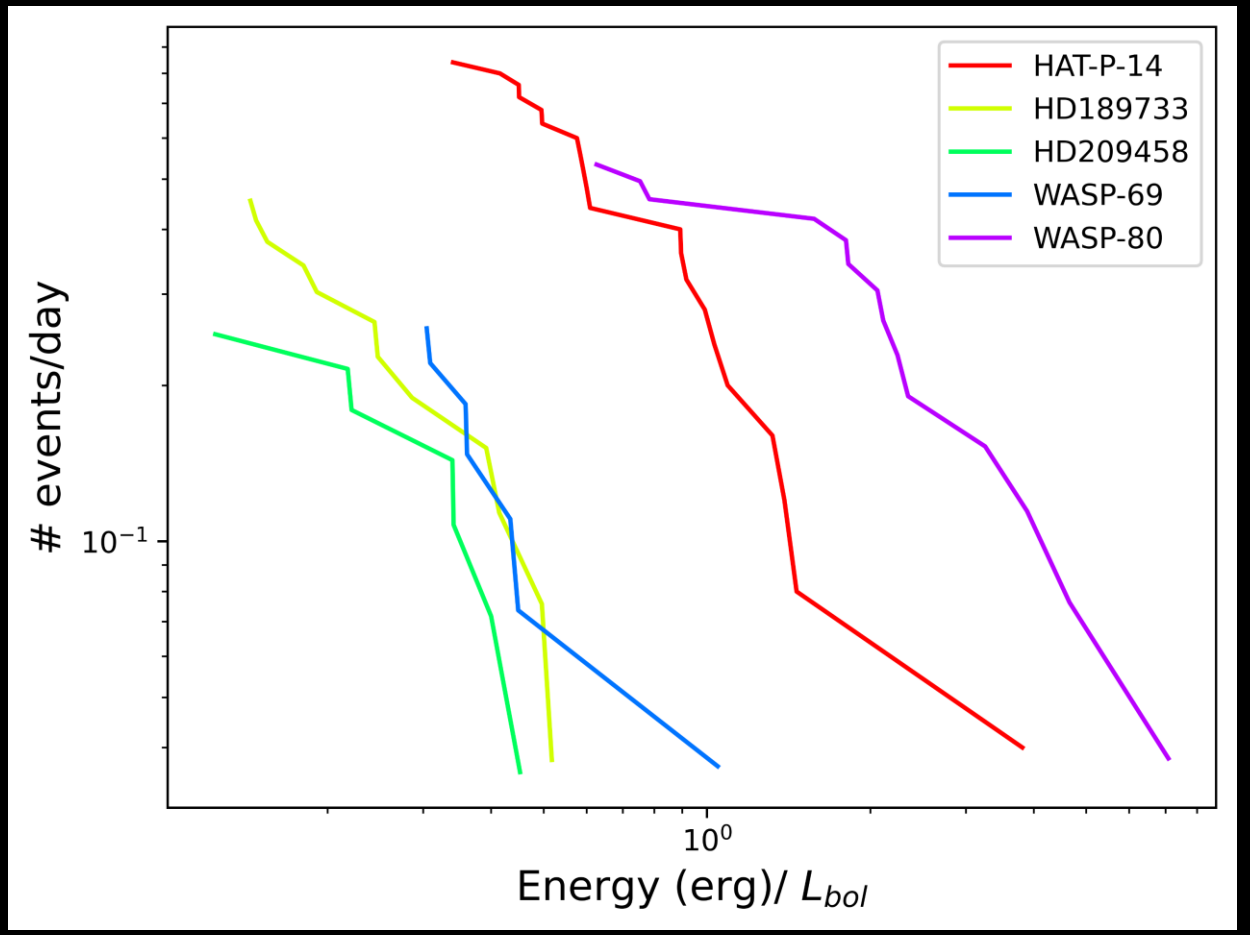




RESULTS NORMALIZED WITH L_{BOL}

Cumulative energy frequency distribution





GP ROTATION PERIOD ANALYSIS (THIS WORK)

STAR	τ (days) (this work)	P_{rot} (days) (this work)	P_{rot} (days) (Bonomo+2017)	TESS SECTORS
HAT-P-14	$1.37^{+0.02}_{-0.01}$	$5.72^{+0.92}_{-0.72}$	8.84	25
	$1.54^{+0.1.06}_{-0.76}$	$5.70^{+1.25}_{-1.14}$		26
	$1.48^{+1.04}_{-0.63}$	$5.14^{+1.84}_{-0.91}$		52
	$1.56^{+1.23}_{-0.17}$	$5.41^{+2.00}_{-1.19}$		53
HD 189733	$16.57^{+4.46}_{-4.63}$	$12.57^{+0.16}_{-1.12}$	11.95	41
	$13.28^{+2.21}_{-2.06}$	$11.40^{+0.131}_{-0.08}$		54
HD 209458	$5.23^{+1.78}_{-1.76}$	$12.13^{+0.97}_{-0.93}$	10.65	56
WASP-69	$42.24^{+11.38}_{-9.23}$	$20.45^{+1.00}_{-0.16}$	23.07	55
WASP-80	$8.37^{+2.85}_{-0.27}$	$8.40^{+1.14}_{-1.37}$	8.13	54

CONCLUSION

- HAT-P-14 and WASP-80 are the most flaring stars
- GP rotation periods roughly consistent to literature's rotation periods
- More in-depth analyzes will be done on the rotation periods

THANKS FOR THE ATTENTION!