class young-stellar-flares(object):

"""

This poster presents results from Feinstein+(2020; arXiv:2005.07710)

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"""

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def __init__(self):

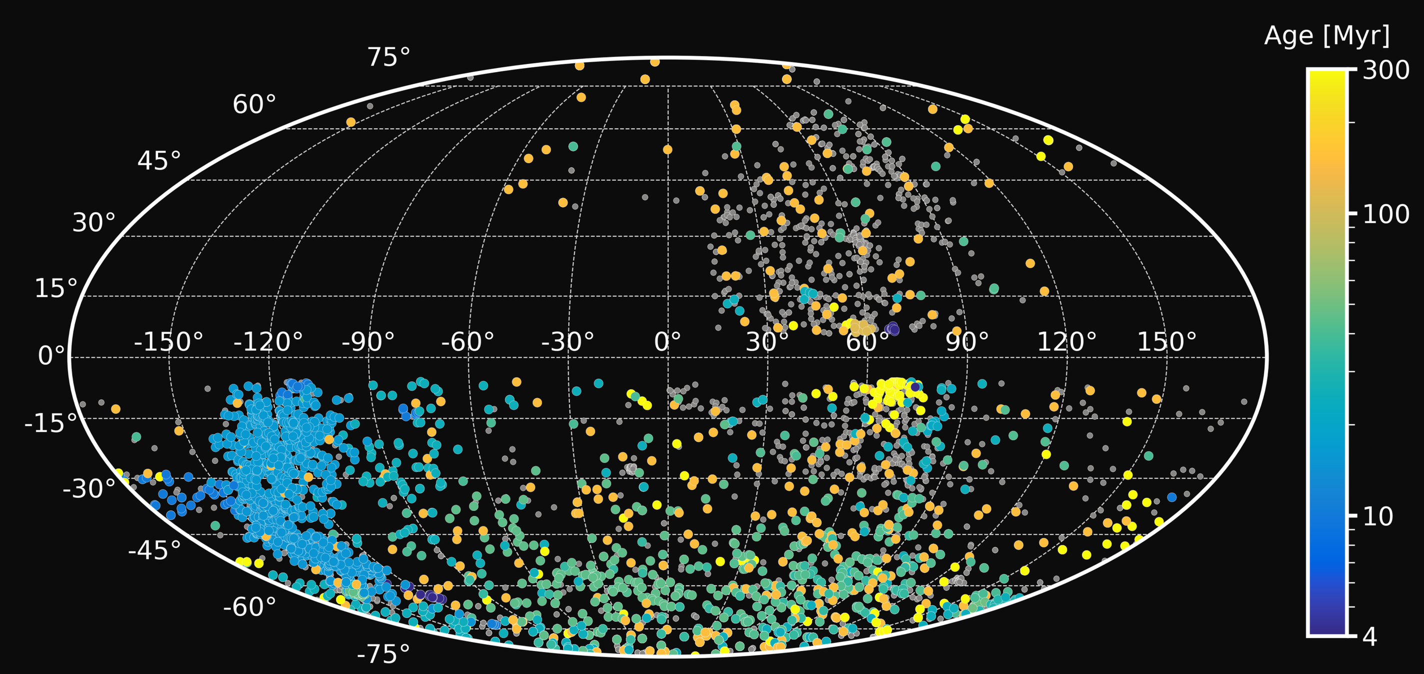
"""
Main takeaways from our study.
"""

- M dwarfs have consistently high flare rates across the first 800 Myr, while hotter stars have fewer flares over time.
- M dwarfs with T_{eff} < 3200 K have the highest normalized energy flares in the sample.
- We find no dependence between flares and spot phase, suggesting a large, mostly uniform distribution of spots in longitude space.

def methods(self):

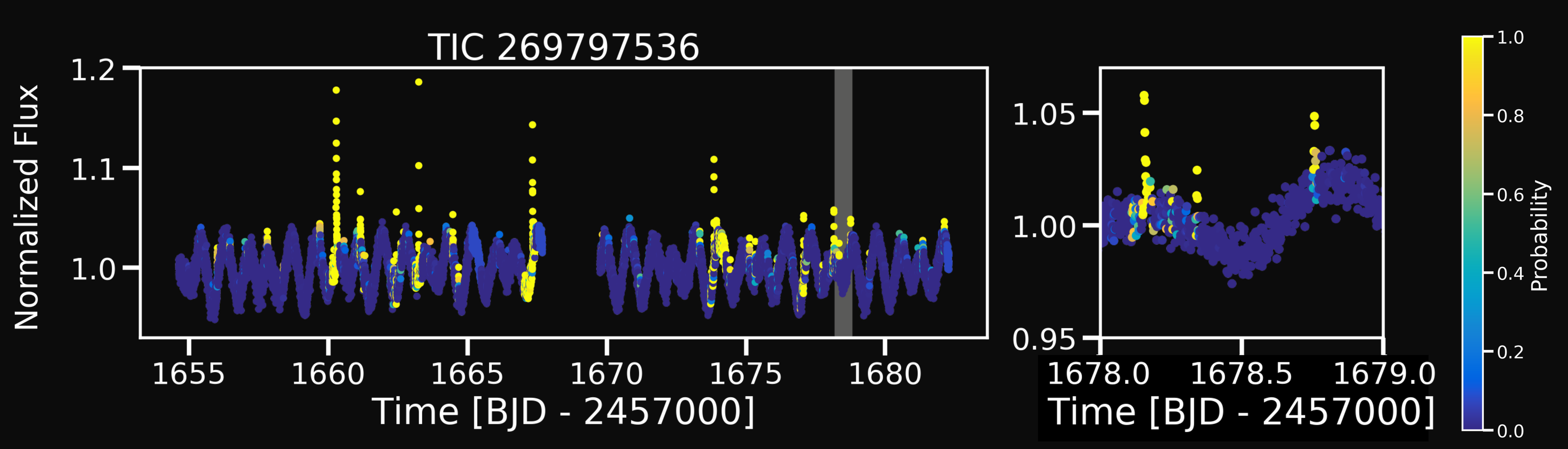
import banyan-sigma

- Young stars were identified through a literature search. The Gaia kinematics were run through banyan-sigma to assign each star to a young moving group, open cluster, OB association, or star forming region.
- Our final sample included **3200 young stars** observed at 2-minute cadence in TESS Sectors 1-19.



import tensorflow as tf

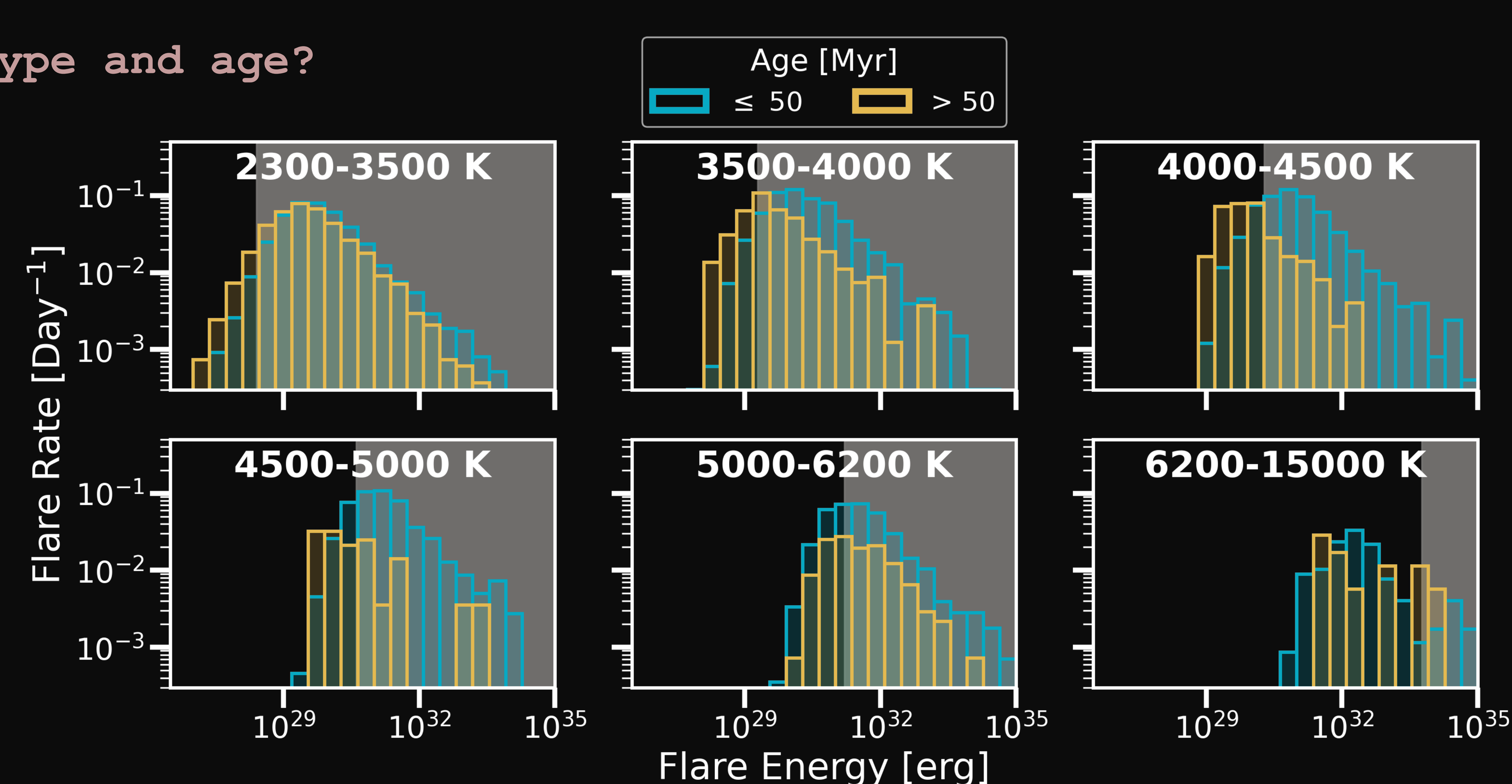
- To identify flares, we trained a convolutional neural network (CNN), **stella**, on the flare catalog from Gunther+2020.
- With **stella**, we are able to assign a probability that a given cadence is part of a flare. By assigning probabilities, which is traditionally not done in other flare detection techniques, we are able to say something truly statistical about flare rates.



def flare-rates(self, bin_by='age'):

"""
What relationships do we find between flare rate and spectral type and age?
"""

- There is a noticeable drop-off in flare rate and energy as the star's temperature increases. M and late K type stars (T_{eff} < 4000K) experience similar flare rates and energies across the entire age range of the sample.
- The high-energy flare tail extends out to 10^{35} ergs and is most noticeable for t_{age} < 50 Myr.
- T_{eff} > 6200K corresponds to the Kraft break and thus a change in internal structure, which may be the cause of such a lack of flares.

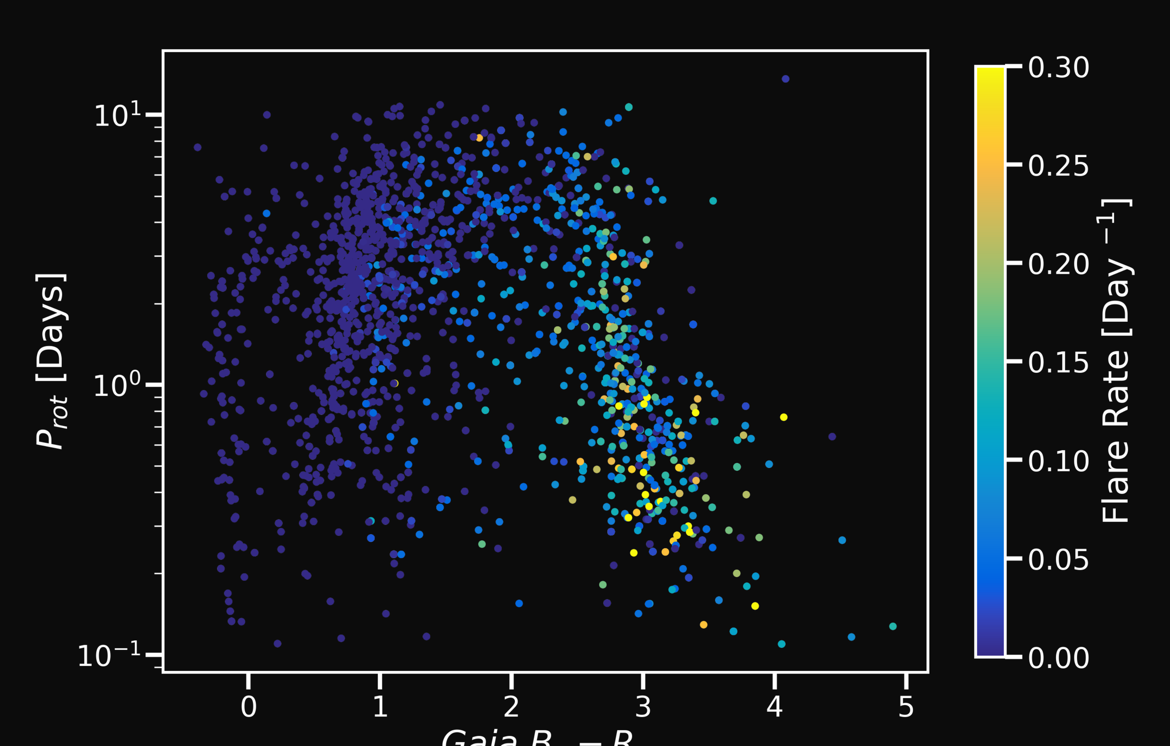


The gray shaded region corresponds to the energies at which we expect to be able to detect flares on all stars in that sub-panel.

def rotation-periods(self, relationship=None):

"""
What relationship do we find between flares and rotation period?
"""

- We were able to measure rotation periods (P_{rot}) for 1500 stars.
- Plotting as a function of Gaia color, we see a noticeable decrease in flare rate at Bp - Rp = 2 (which corresponds to T_{eff} = 4000K).
- Most stars with Bp - Rp > 2 do not exhibit any flares, while the cooler stars show a variety of flare rates across all rotation periods.
- There is an artificially induced break at P_{rot} > 12 days, as the result of our rotation period metrics.



"""
What relationship do we find between flares and spot phase?
"""

- We were able to measure rotation periods (P_{rot}) for 1500 stars.
- There is no preference for where flares occur with respect to phase. Here a phase = 0 is the peak of the rotation modulation (i.e. the less spotted hemisphere).
- These results are consistent with Doyle+(2018, 2019, & 2020).
- These are also consistent with high (> 80%) spot coverages, as seen in Gully-Santiago+2017.
- The result presented here is the largest sample of young stars for which such an analysis has been completed.