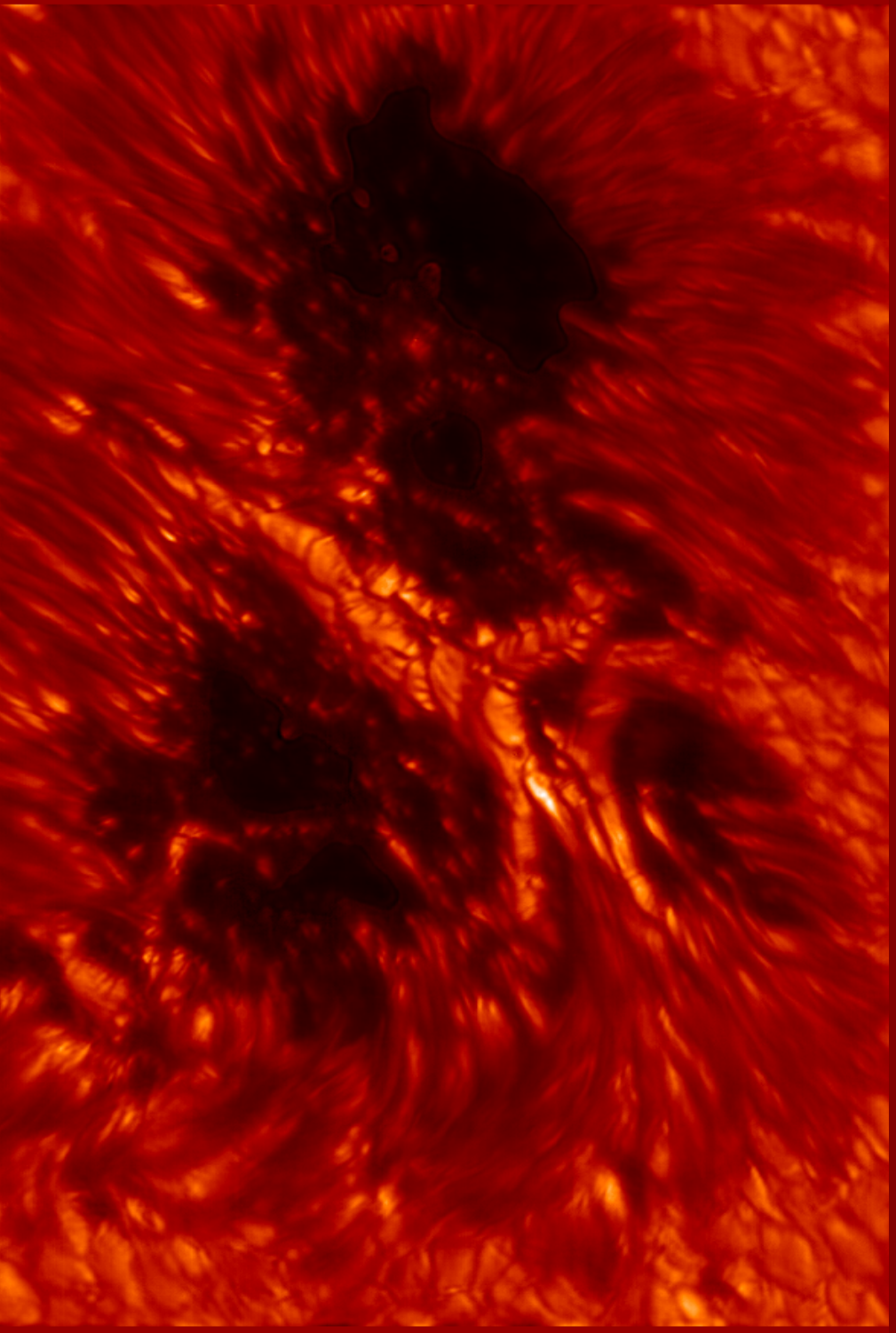

Identification of chromospheric dynamical signatures in solar flares with DKIST

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Department of Physics
[2]DKIST Ambassador,
National Solar Observatory

Hinode-17/IRIS-15/Sphere-3 Conference
2024 Jul 26

- Investigate the **temporal-spatial scales** of flare energy release, and dynamics at these scales, and use these signatures to diagnose associated physical mechanisms involved in flare loop heating.

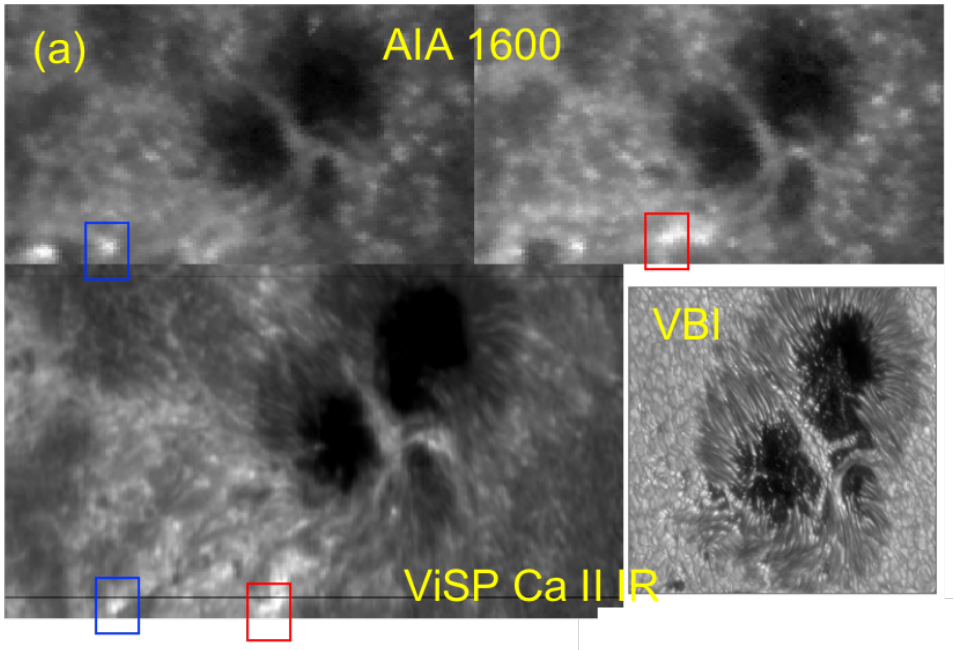
Motivating Question

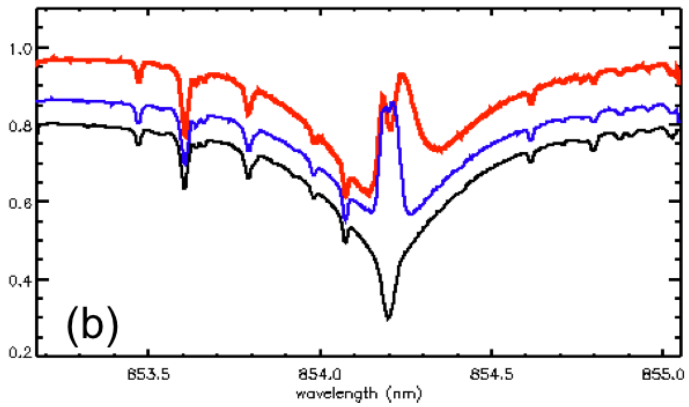
- What dynamical signatures are associated with different evolutionary stages of solar flares?

Introduction

Dynamical signatures

- Atmospheric energy transfer mechanisms
  - Thermal conduction
  - Non-thermal electrons
  - Waves
  - etc...





N-D k-means

$$\text{data}_m = X_m = \left(x_{m,1} \quad , \cdots , \quad x_{m,n}\right)$$

Goal: Minimize the "Within cluster distance"($\mathcal{D}$).

$$\mathcal{D} = \sum_{i=1}^{M} \sum_{j=1}^{k} \delta_{c_i,j} ||X_i - \mu_j||^2$$

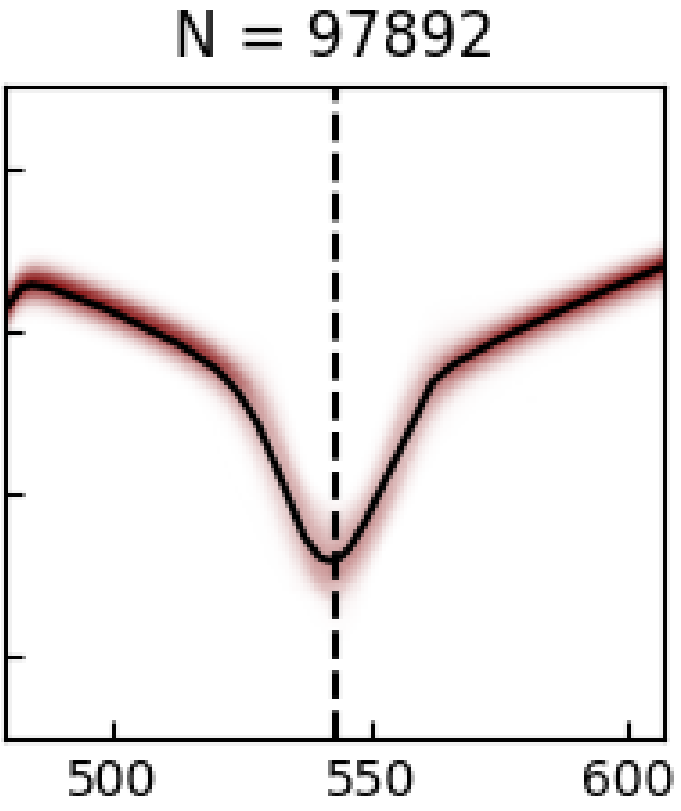
Iterative approach

- Update the label association

$$c_j = \underset{1 \leq j \leq k}{\text{argmin}} ||X_i - \mu_j||^2$$

- Update the decision centroid

$$\mu_j = \frac{1}{M_j} \sum_{i=1}^{M} \delta_{c_j,j} X_i$$



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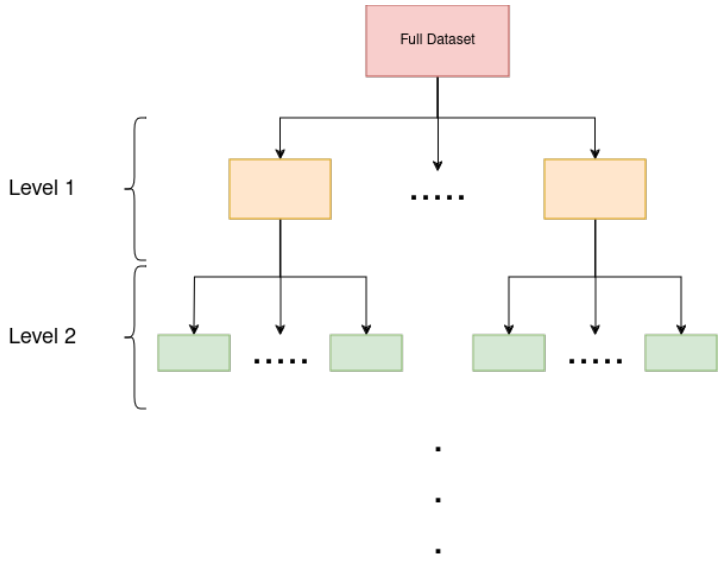
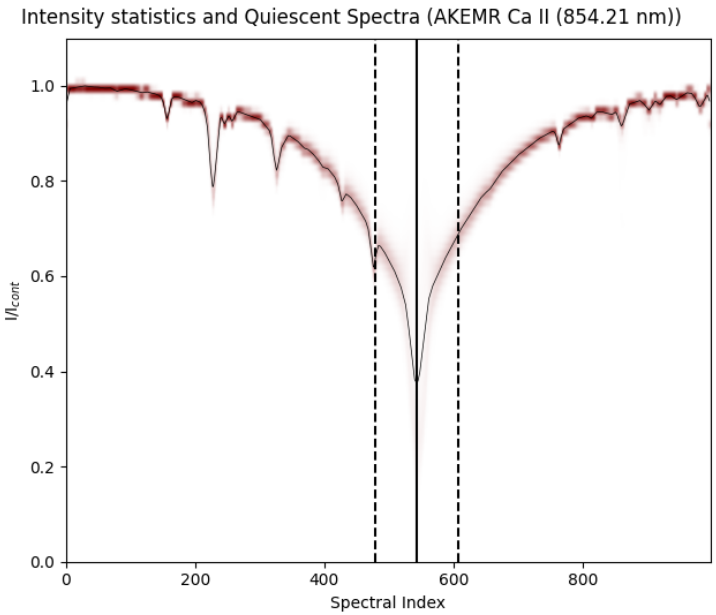
Hierarchical k-means

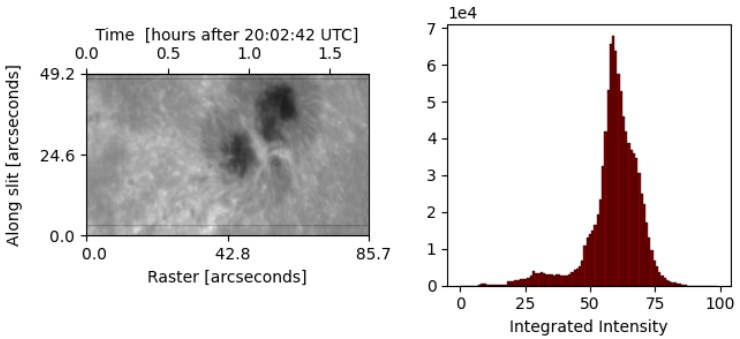
- Useful when the data has structure.
- Improved computational performance



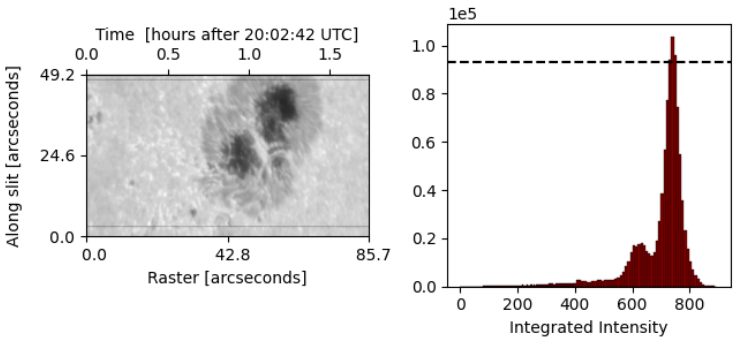
Current results

2022 Dec 27 (AR 13176)





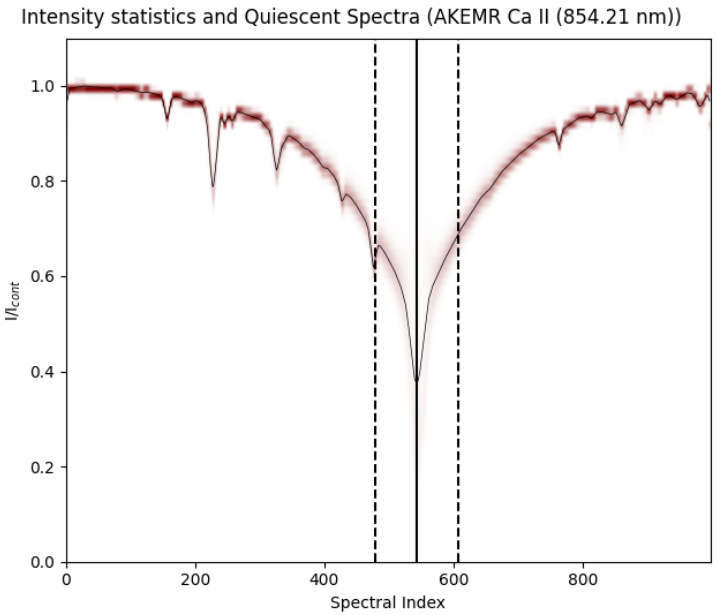
Intensity calculations with the spectral interval

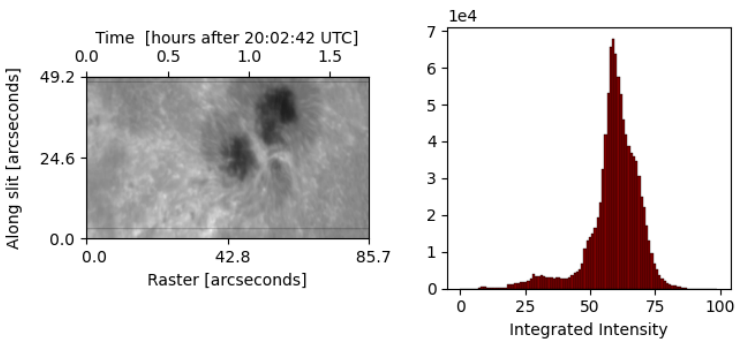


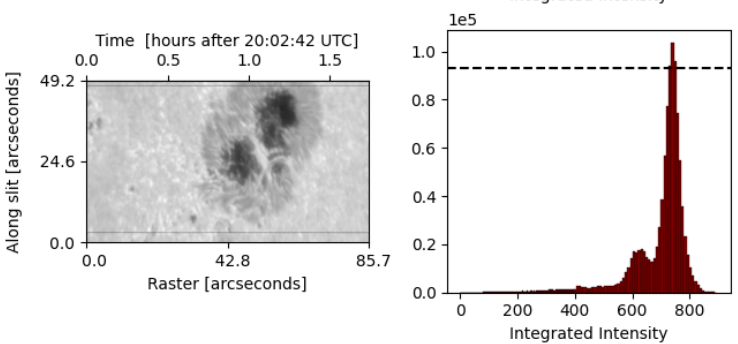
Intensity calculations with the full spectrum

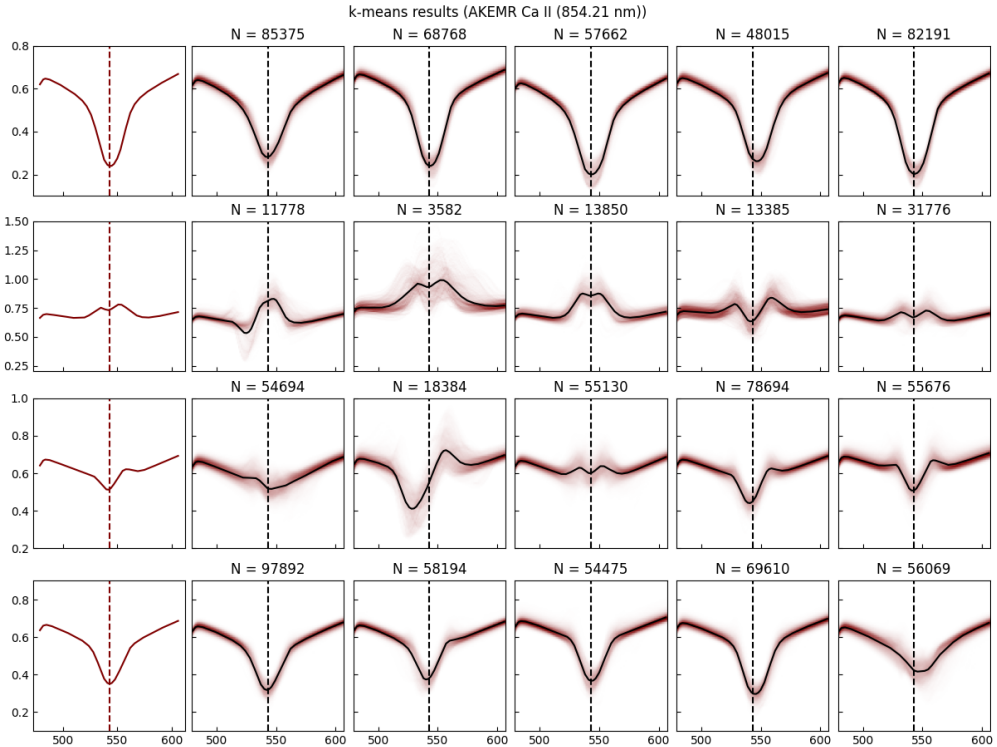
Current results

2022 Dec 27 (AR 13176)









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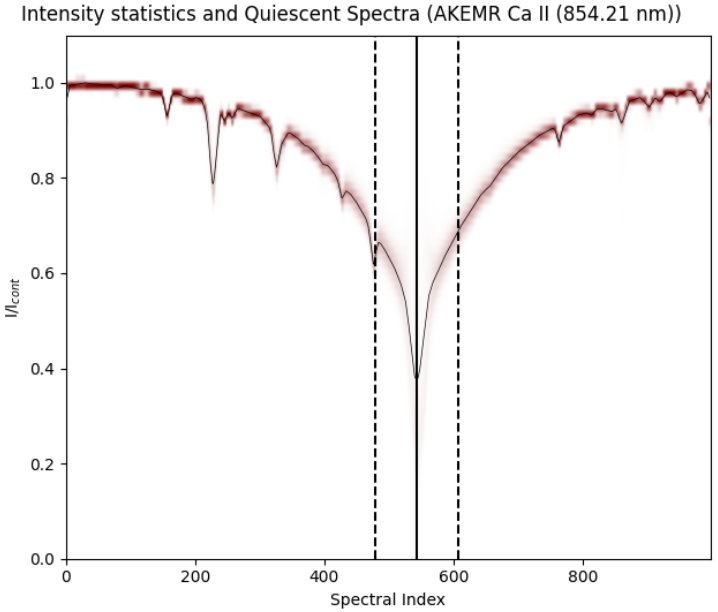
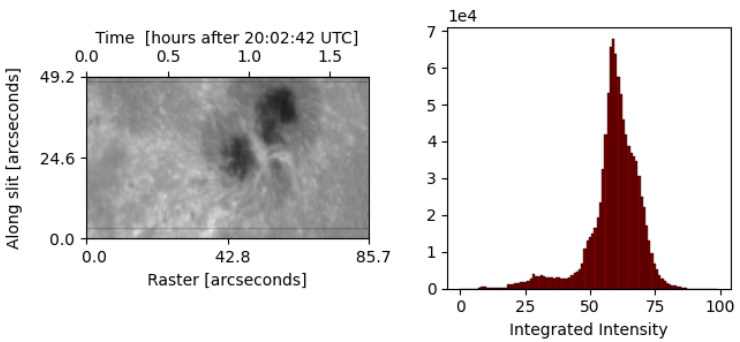
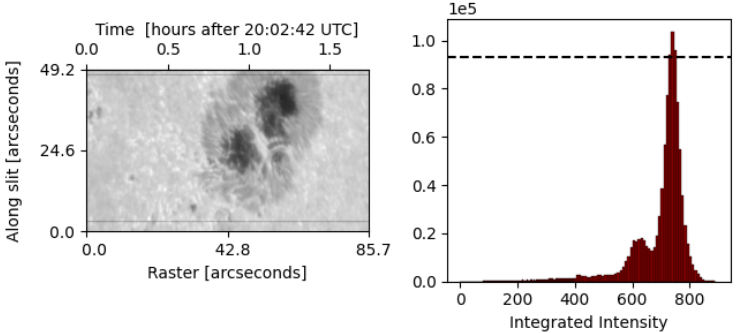
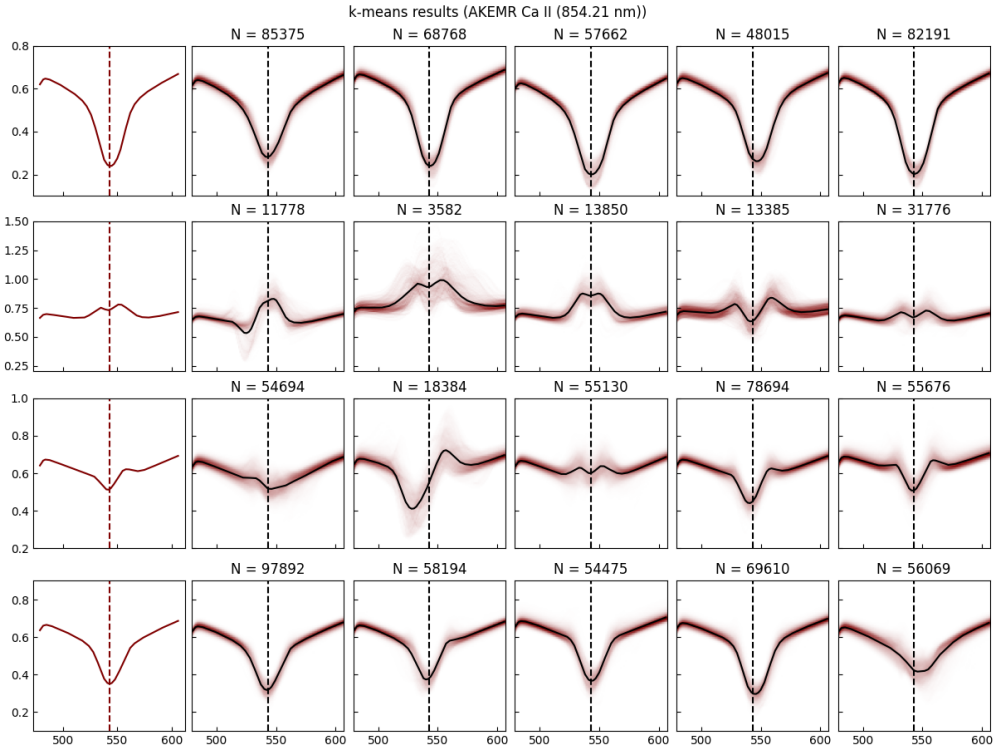
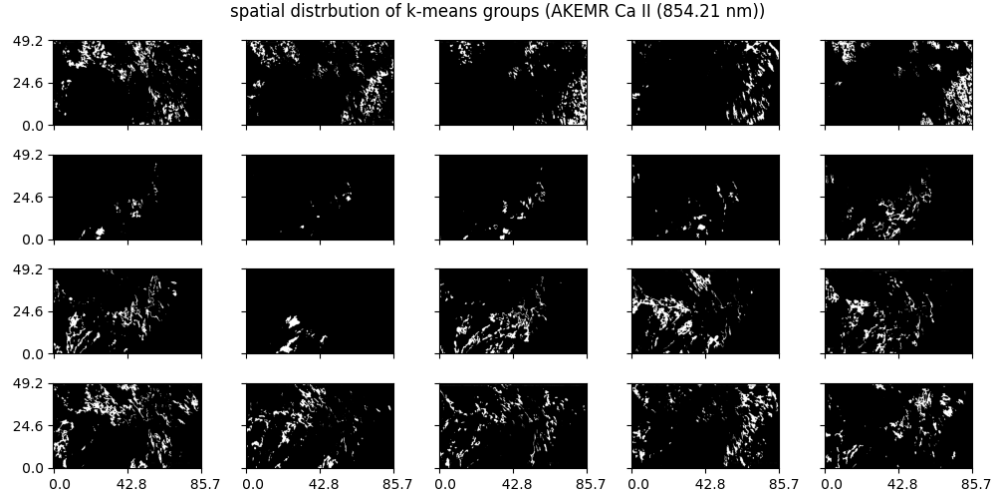






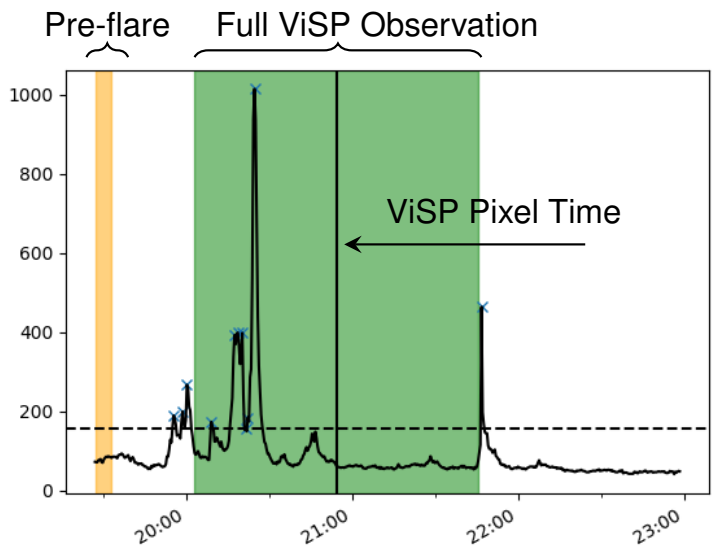


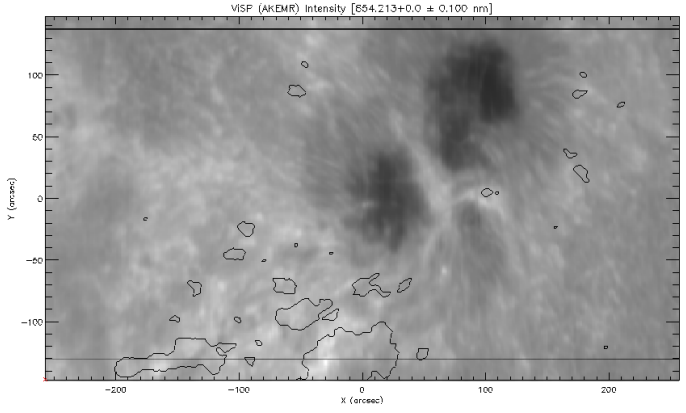


Current results

Time analysis

Spectral profiles in time





$\Delta t =$ ViSP Obs Time $-$ AIA Peak Time

- $\Delta t > 0$ (Decay Phase)
- $\Delta t < 0$ (Rise Phase)

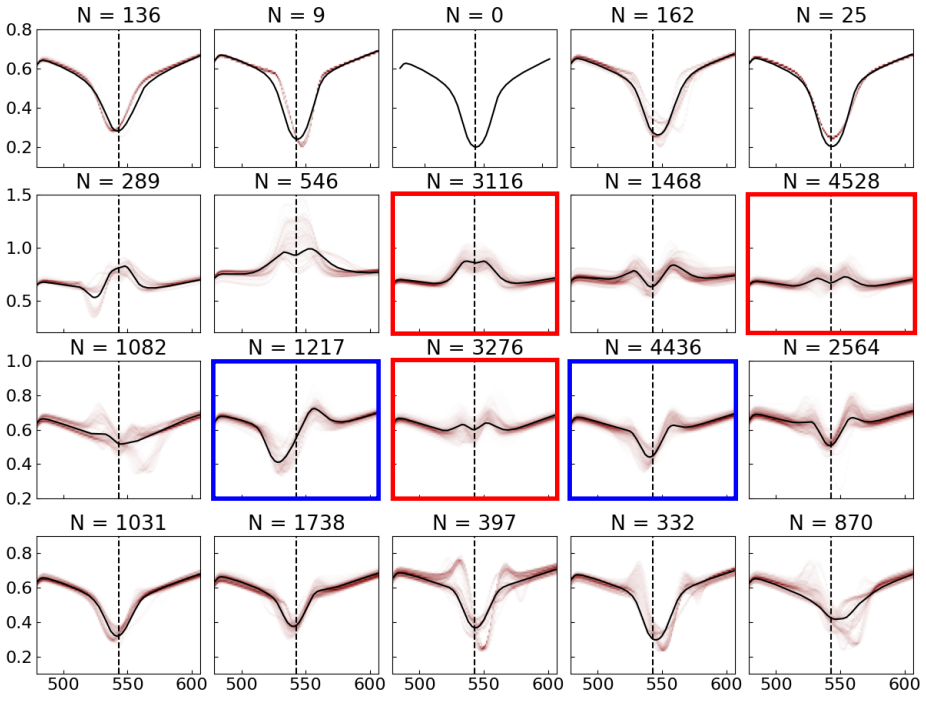
Filters

- AIA 1600 Peak $\geq 2\times$ Pre-flare
- Only Flaring Pixels

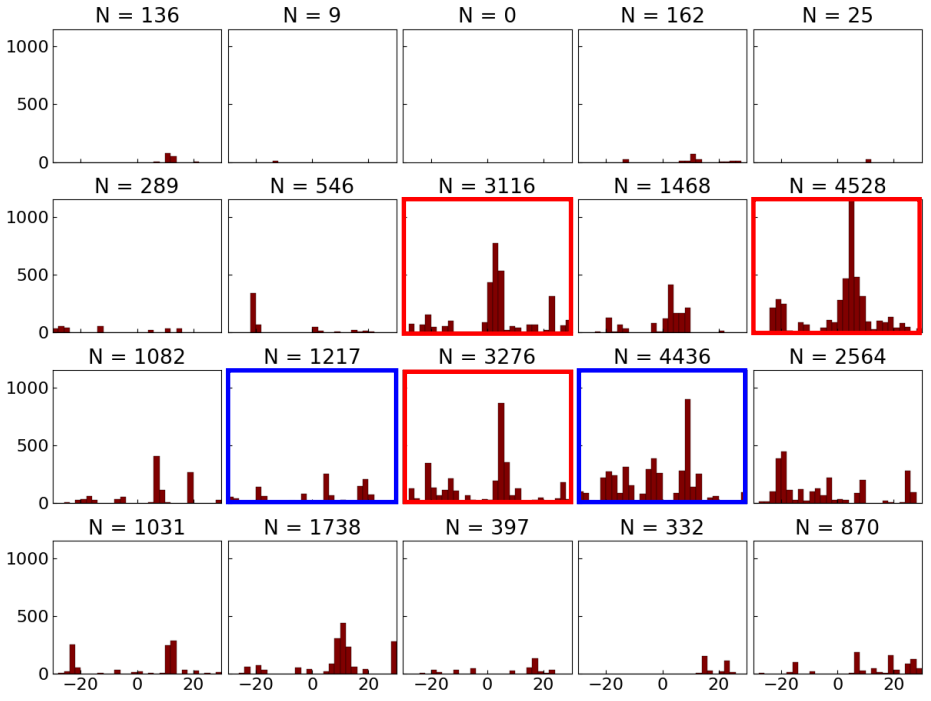
Current results

Time analysis

Filtered subset



$\pm$ 30 minutes interval

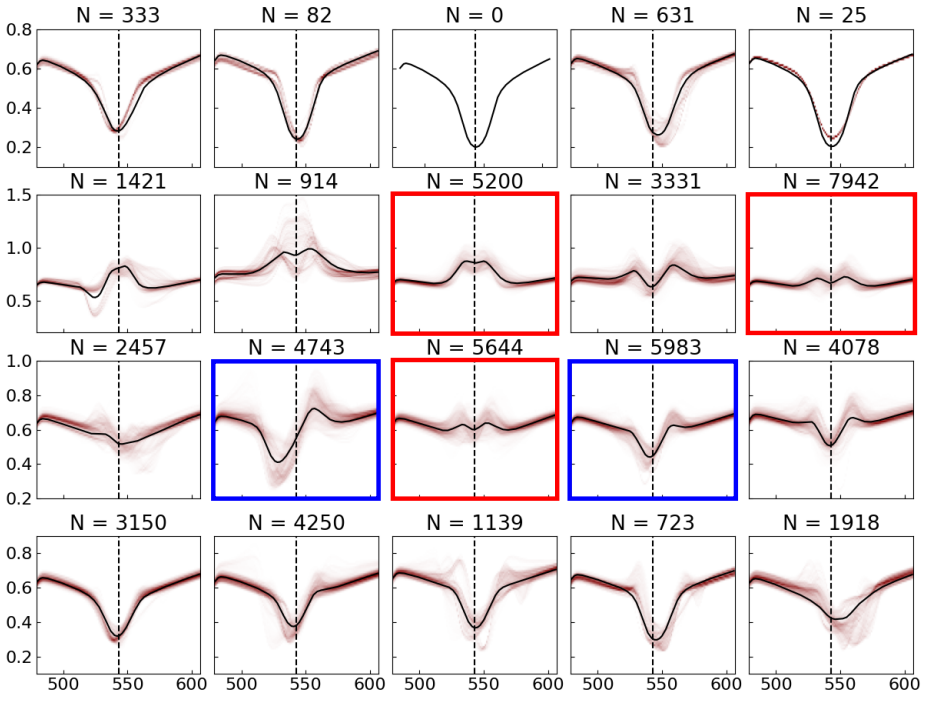


- Centroid reversal groups most dense: $|\Delta t| \leq 10$ minutes
- Asymmetric absorption groups most dense: $|\Delta t| \geq 10$ minutes

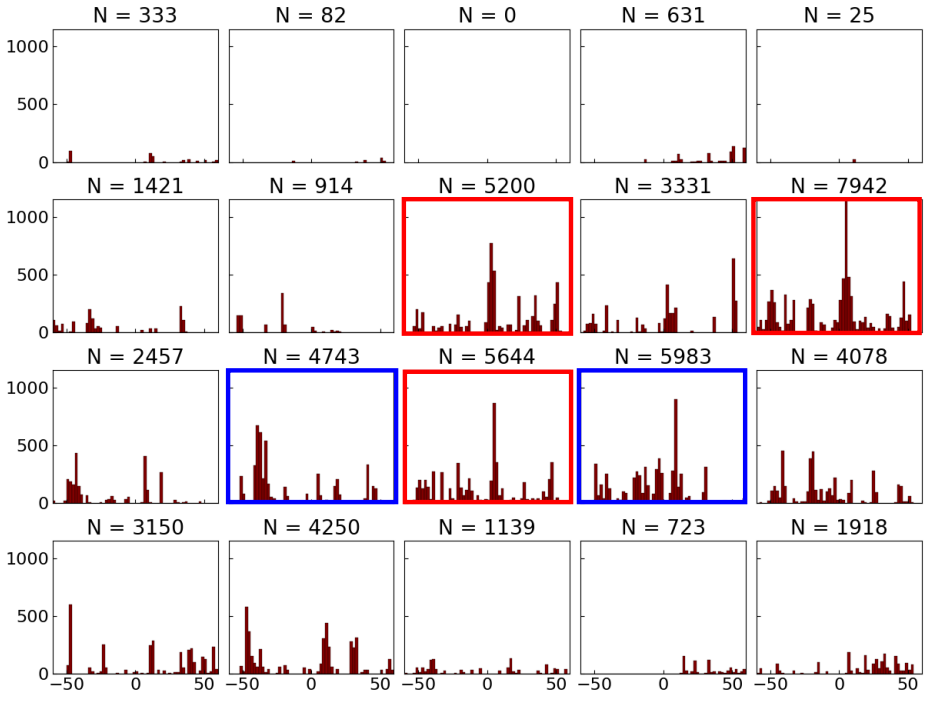
Current results

Time analysis

Filtered subset



$\pm$ 60 minute interval



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Concluding remarks

Review

From the **k-means analysis** :

- We efficiently identified dynamic signatures on the DKIST scale

From the **time analysis** :

- We showed how the dynamic signatures are distrbuted in the AIA 1600 evolution of a flaring pixel

Next steps

- Utilize ViSP/VBI observations to conduct time analysis
- Compare the decision centroids to radiative transfer model derived spectra

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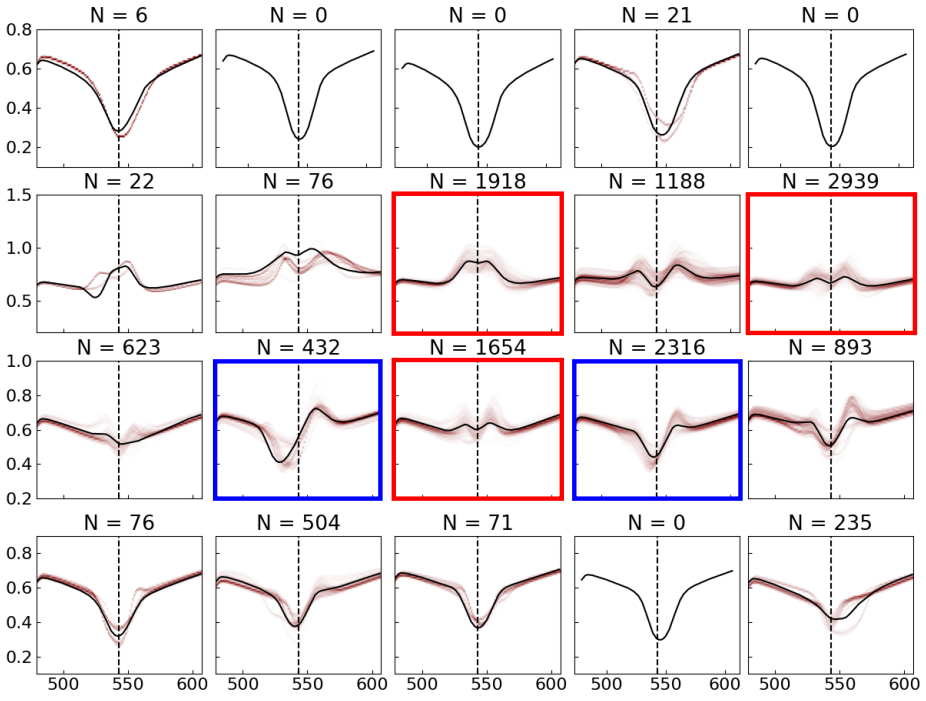
Thank You

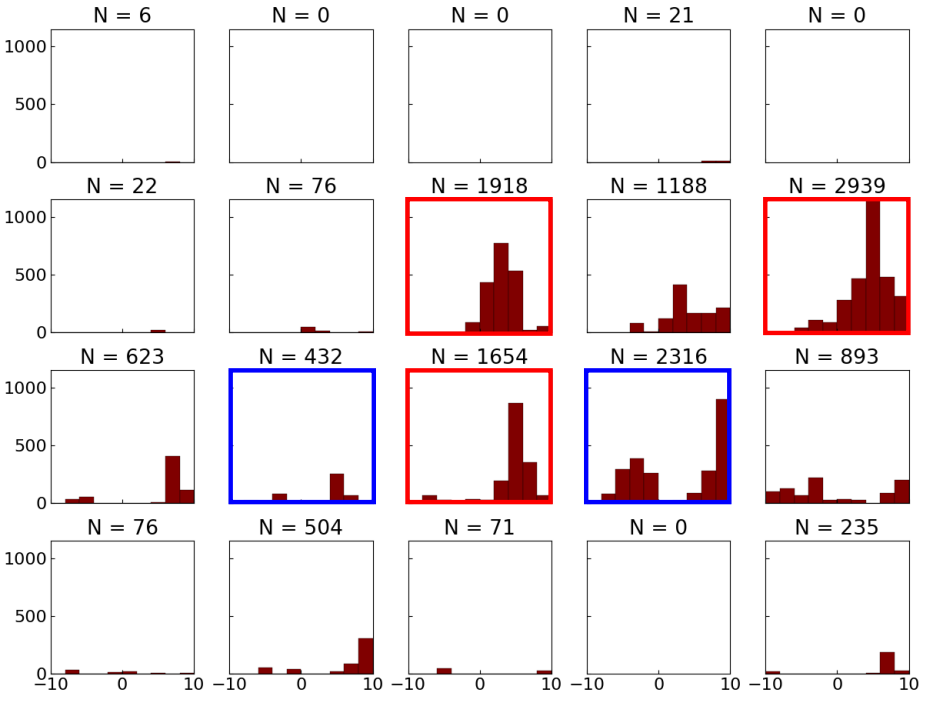
spencerriley@montana.edu

Backups

Filtered subset



$\pm$ 10 minute interval



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