Can Geostationary Operational Environmental Satellite (GOES) ultraviolet measurements predict the x-ray properties of flares?

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INTRODUCTION

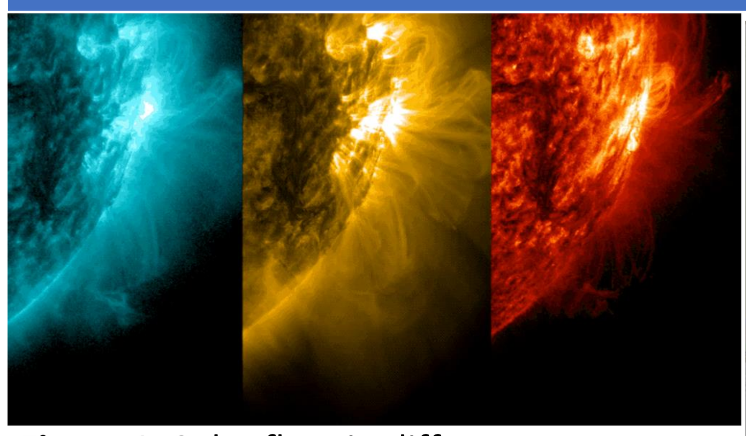

Figure 1: Solar flare in different wavelengths

- Solar flare is a short and intense blast of high energy radiation from the Sun. Sun that occurs when the Sun's magnetic field gets entangled and snaps. (Sharma, A et al., C., 2017

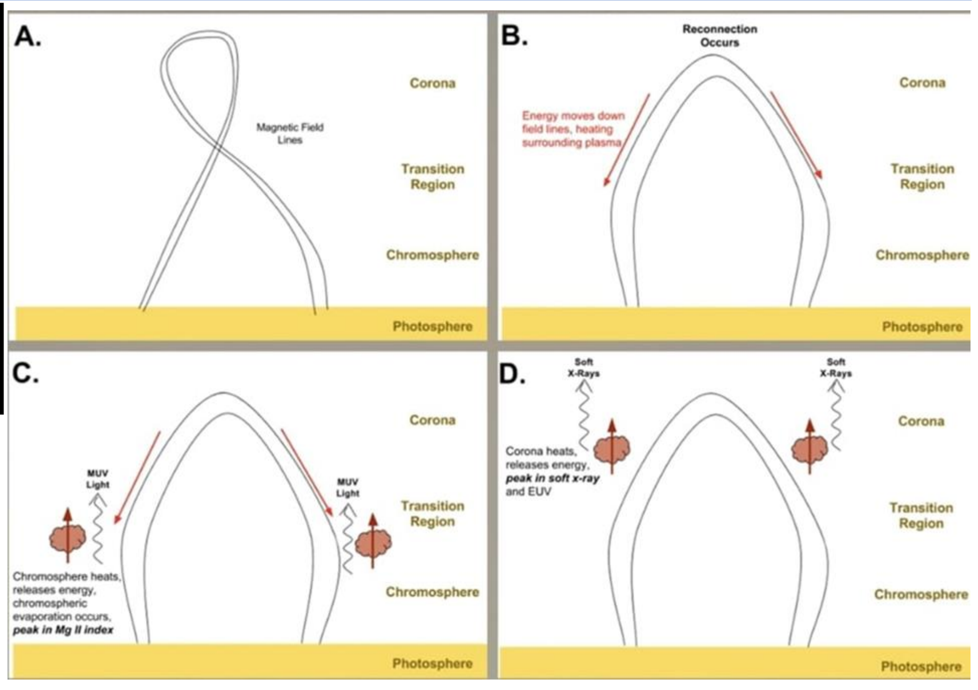

Figure 2: Flare model

ANALYSIS

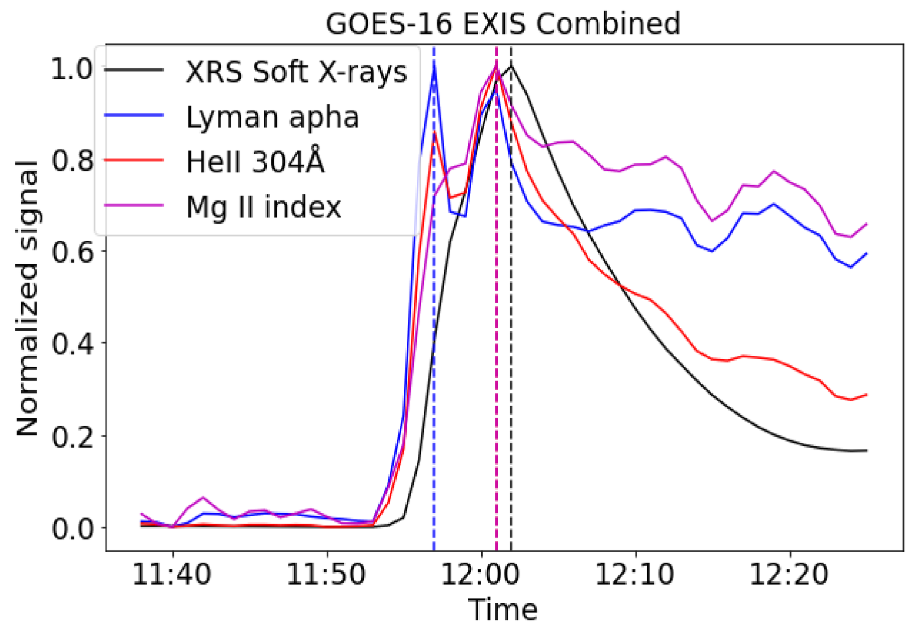

Figure 4 : Change in different wavelengths during a flare

This research project involves analyzing solar flare data obtained from the GOES-16 EXIS instrument via the NOAA website, including UV and X-ray measurements. Python software will be used for data analysis, seeking patterns and relationships between UV and X-ray properties. If significant relationships are found, a predictive model will be developed to forecast the class and duration of X-ray flares based on UV observations

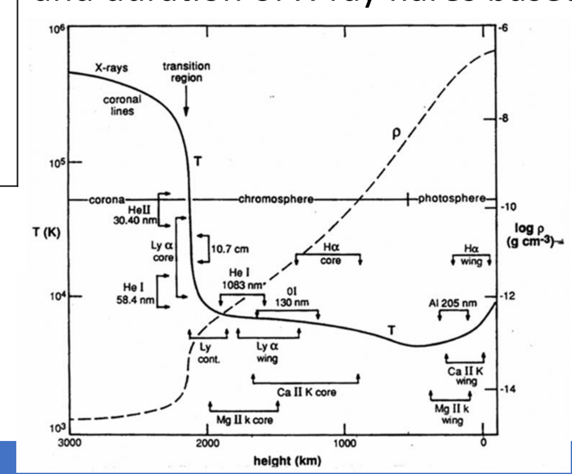

Figure 3. This plot shows the formation heights of various spectral features

RESULTS

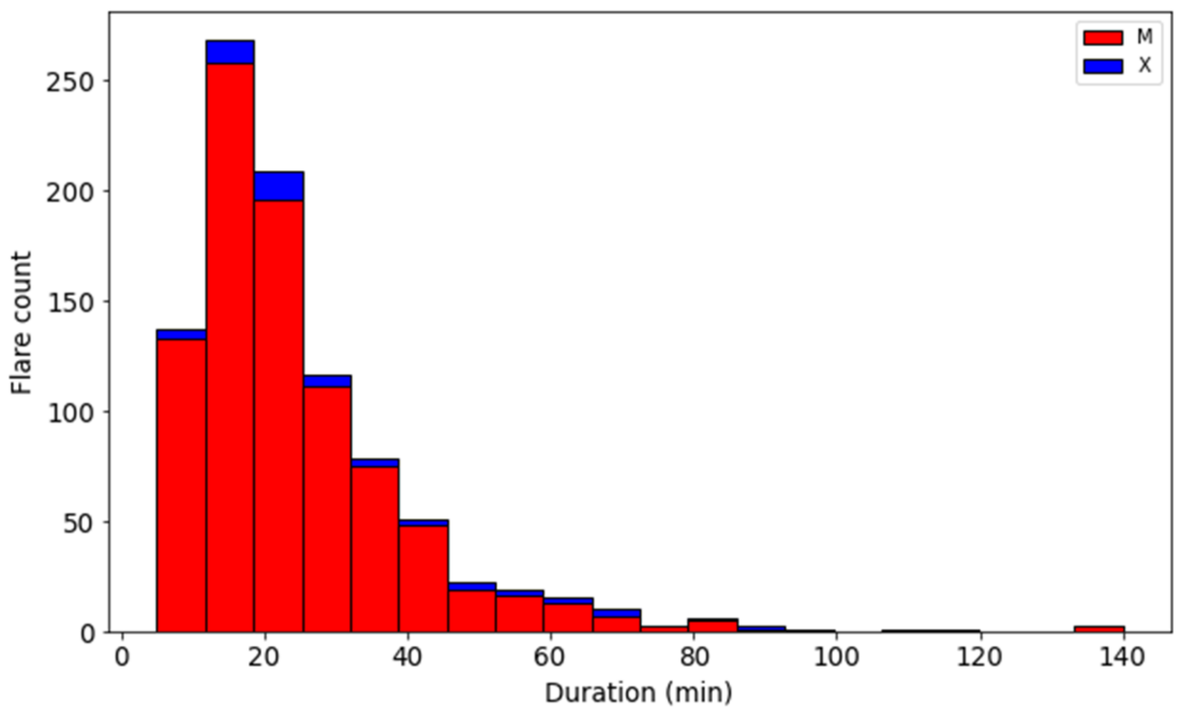

Figure 5: Duration of X and M class flares
Most flares last under 30 minutes, though some range from minutes to hours. Long-duration flares (>120 minutes) (Erica Nathan.et al,2017). Flare length is independent of flare class and GOES data underestimates duration by only recording part of the decay phase.

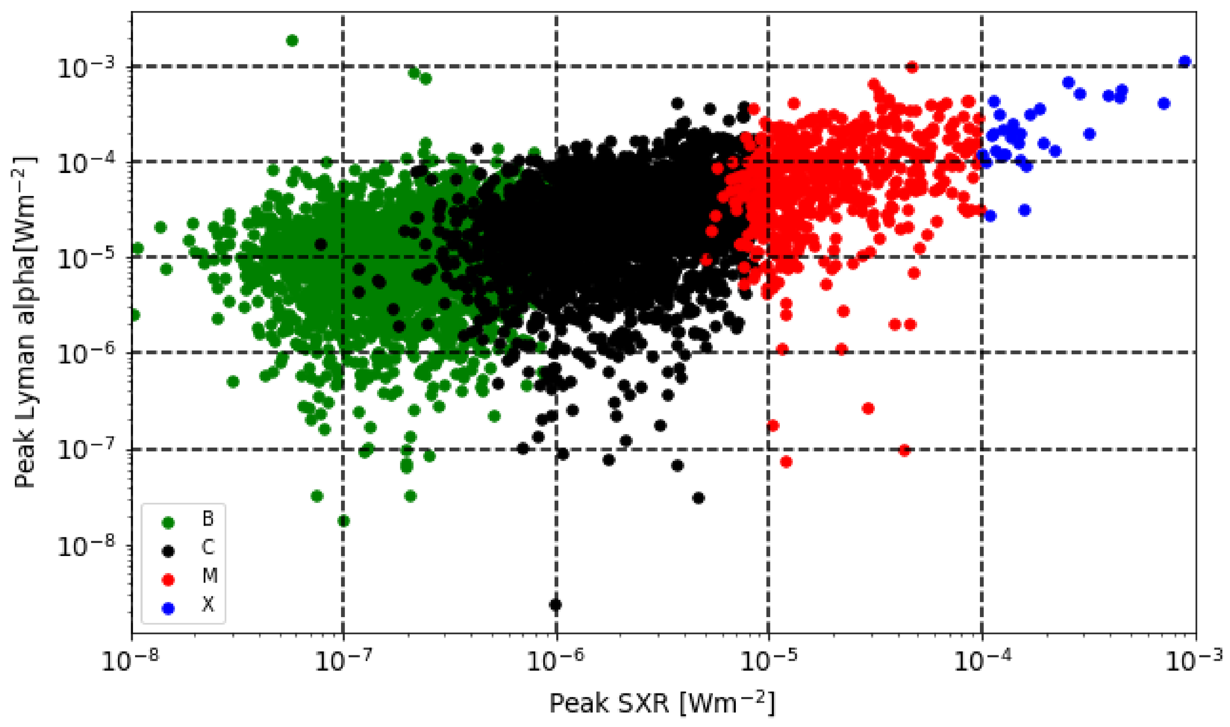

Figure 6: Peaks of Lyman alpha vs the peaks of the soft X-ray flux for all flare classes illustrating the relationship between peak Lyman alpha flux and soft X-ray. It shows a clear trend where weaker Lyman alpha emissions align with lower X-ray fluxes, while stronger emissions occur during more intense flares. This indicates the strong potential of Lyman alpha flux in predicting flare intensity based on the X-ray emission profile.

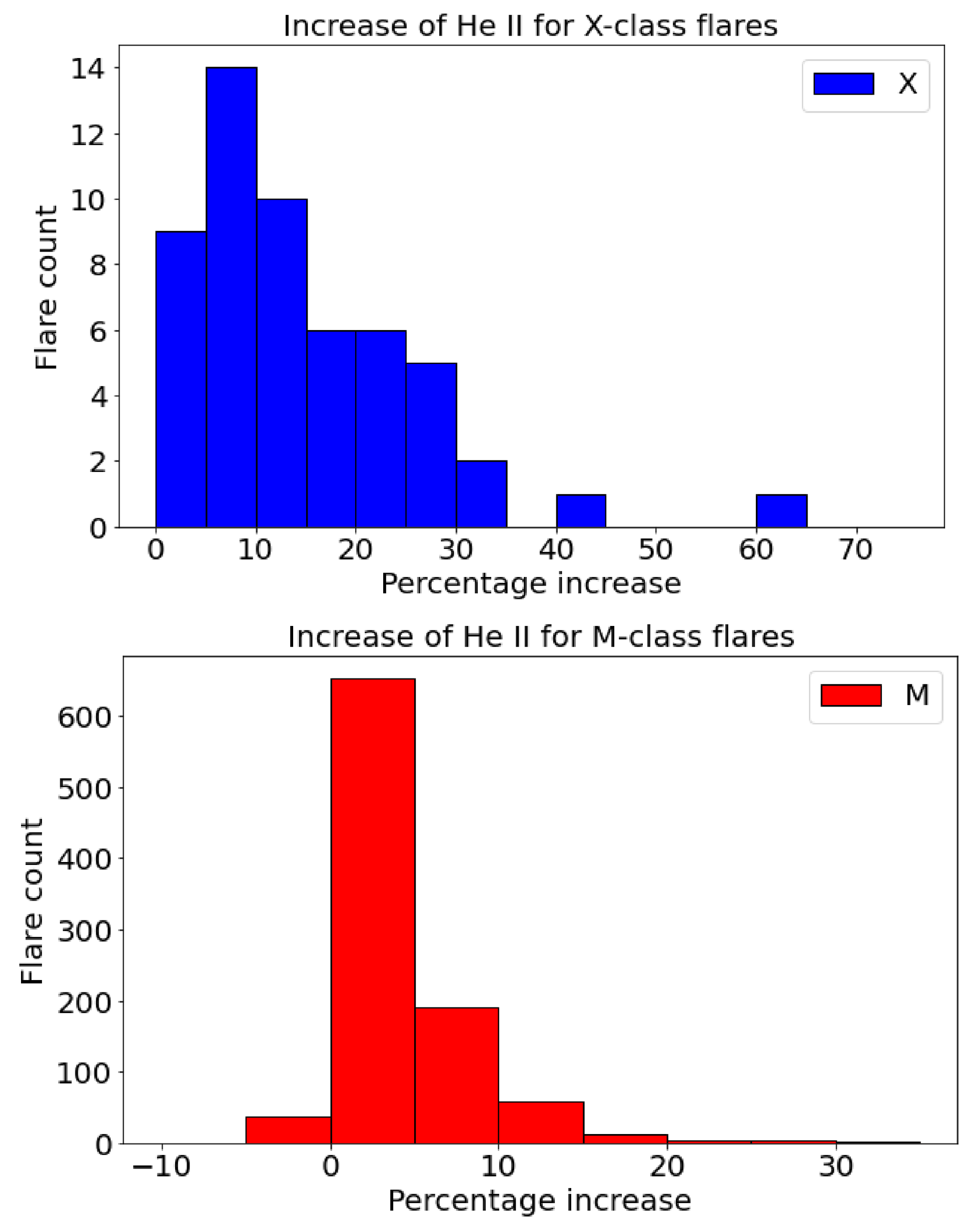

Figure 7: Percentage increase of He II for X-class and M-class flares above background. It is worth noting in figure 4.3 that when He II increases by 20% or more above background then it is likely to be X class flare. This is justified by the fact that only 1% of M class flares show a He II increase of 20% or more.

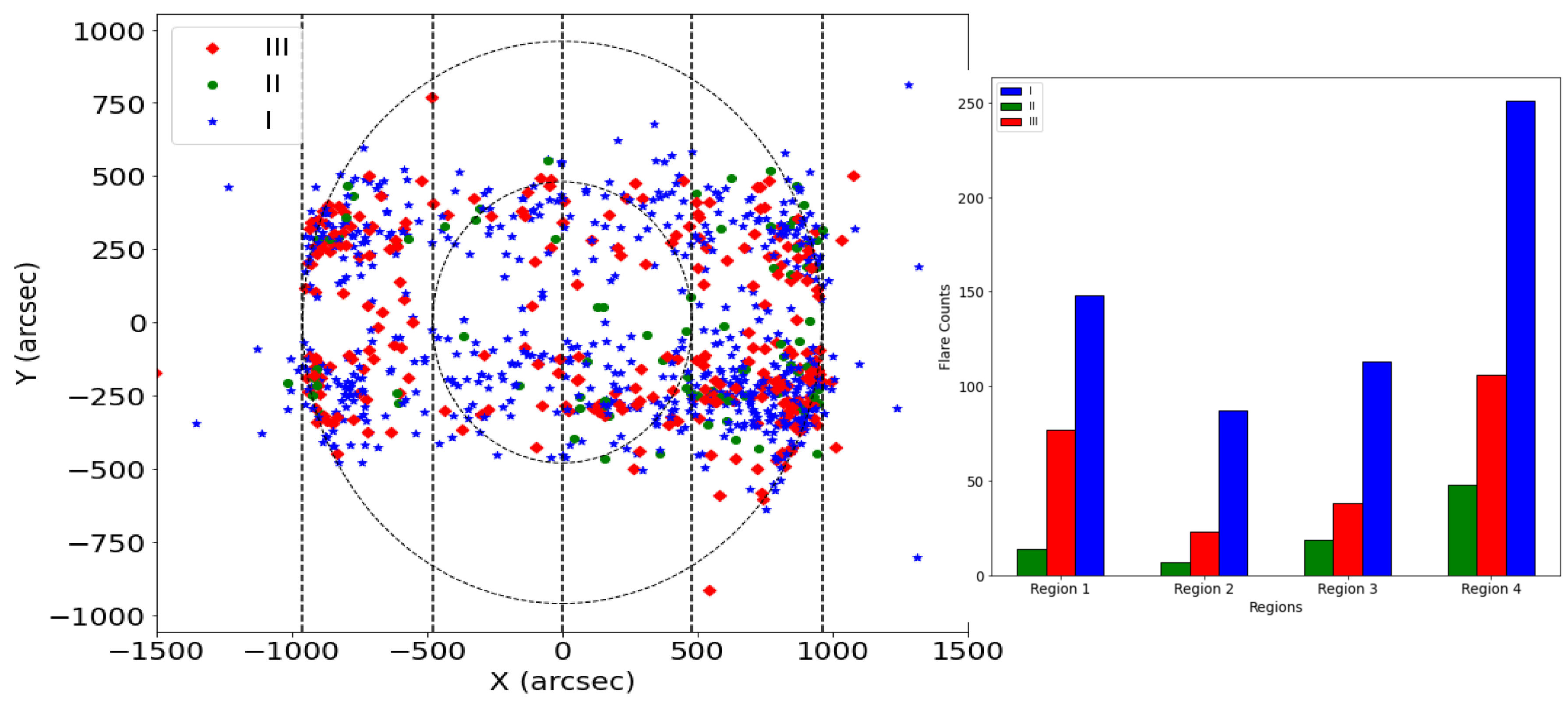

Figure 8: The left plot shows the spatial distribution of flares on the solar disk with the solid circle (R = 960) marking the solar limb and the disk is divided into 4 sections to investigate the foreshortening effect. The dashed circle(R = 480). The plot on the right shows the flare count in each section.

1231 M & X CLASS FLARES ANALYSED (2017-2024)

Type I: Flares where the EUV emission peaks before the SXR.
Type II: Flares where EUV and SXR reach their peaks almost simultaneously.
Type III: Flares where the SXR peak before EUV

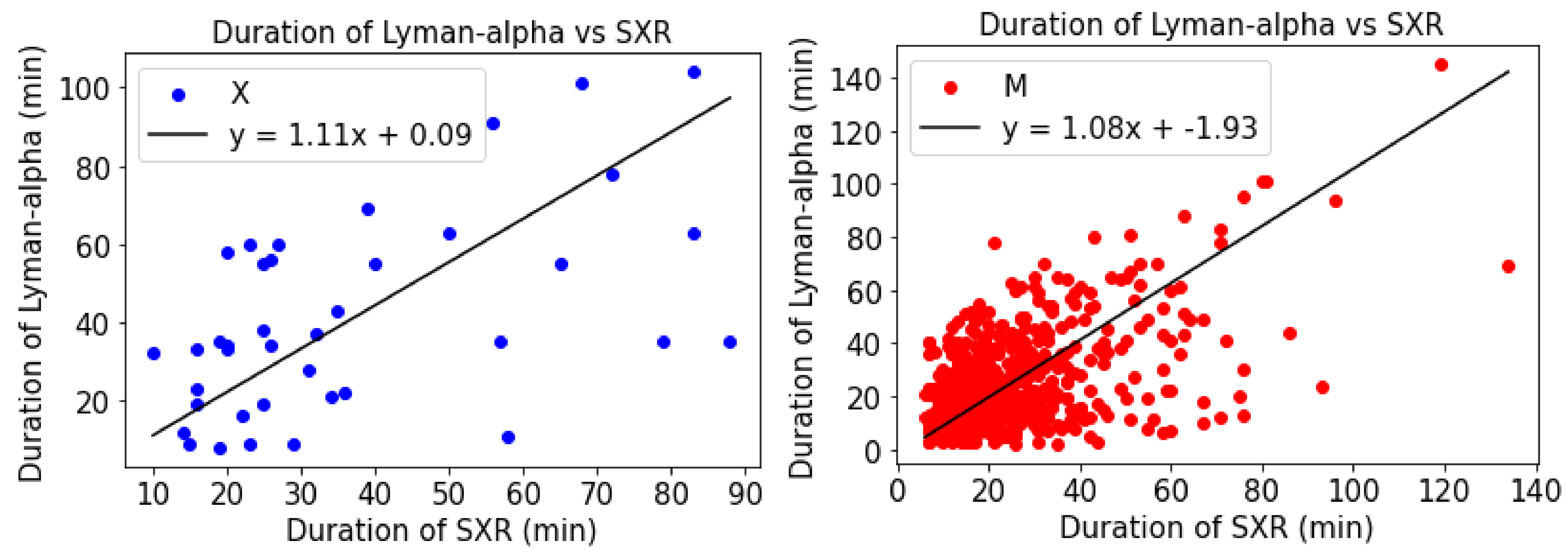

Figure 9 (left) Duration of Lyman-alpha versus the duration of SXR for Type I X-class flares (right) Duration of Lyman-alpha versus the duration of SXR for Type I M-class flares.

CONCLUTION

Type I ~70%

AVERAGE TIME EUV PEAK FIRST

Lyman alpha	5.2 mins
He II	4.4 mins
Mg II index	5.0 mins

STRENGTH OF EUV VS SXR

Lyman alpha	r = 0.32
He II	r = 0.53
Mg II index	r = 0.43

DURATION OF EUV VS SXR

Lyman alpha	r = 0.57
He II	r = 0.67
Mg II index	r = 0.58

REFERANCES

Images

Image Sources:(1) NASA/SDO
Image from https://www.snexplores.org/article/explainer-solar-cycle
(2) Vernazza, J.E.,etal."Structure of the Solar Chromosphere. III-Models of the EUV Brightness Components of the Quiet-Sun. "The Astrophysical Journal Supplement Series,vol.45,1981,p.635.(Background).

References

1. Erica Nathan, Martin A Snow, Andrew R Jones, and Janet L Machol. Investigating flares and solar global oscillations in mg ii from goes-16 exis. In AGU Fall Meeting Abstracts, volume 2017, pages SH43B–2823, 2017.
2. Roy, S. and Tripathi, D., 2024. Evolution of the Ratio of Mg ii Intensities during Solar Flares. The Astrophysical Journal, 964(2), p.106.

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