

# SOLAR CORONAL COMPOSITION DURING A SOLAR FLARE

ANDY S.H. TO | DAVID M. LONG | DEBORAH BAKER | DAVID H. BROOKS | LIDIA VAN DRIEL-GESZTELYI | J. MARTIN LAMING | GHERARDO VALORI

To, Andy S. H., et al. "The Evolution of Plasma Composition during a Solar Flare." *Astrophys. J.*, vol. 911, no. 2, 19 Apr. 2021, p. 86, doi:10.3847/1538-4357/abe85a.

## SCROLL TO LEARN MORE ABOUT

### SOLAR CORONAL COMPOSITION DURING A SOLAR FLARE

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#### 1. WHY STUDYING COMPOSITION ON OUR SUN IS IMPORTANT?

Although there is only a trace amount of metal on our Sun, complex processes in the solar atmosphere lead to a variation in metal abundances in the corona, compared to the photosphere. Unique Emission Lines of Metals provide us with a tool to study metal abundances, and it could give us an insight into the processes in the solar atmosphere (Alfvén wave induced ponderomotive forces).

**Solar Photospheric Elemental Composition**

Hydrogen	~75%
Helium	~25%
Metal	~1%

#### 2. CATEGORISING COMPOSITION - FIRST IONISATION POTENTIAL (FIP)

High FIP and low FIP elements are separated by this sharp turn at 10eV. In a developed active region, the low-FIP elements are usually more abundant than the high-FIP ones. The ratio between their solar atmosphere abundances to their photospheric abundances is called the FIP bias.

In this analysis, we use two pairs of emission lines, low FIP silicon and high FIP sulphur (~1.5 Å), and the ratio between low FIP calcium and high FIP argon (~2.0 Å).

Our theory is based on the ponderomotive force model by Martin Laming.

First Ionisation Potential (FIP)	
LOW-FIP (< 10eV) Calcium   Silicon	HIGH-FIP (> 10eV) Argon   Sulphur

#### 3. GENERAL VIEW OF OUR INVESTIGATION CANDIDATE - ACTIVE REGION 11967

- Magnetically Complex
- Hosted HGO large explosions called flares, the perfect soil for Alfvén wave induced ponderomotive force!
- The instrument EIS observed the third flare, giving us a unique opportunity to study composition evolution of flares

#### 4. DIFFERENT RESULTS USING TWO PAIRS OF ELEMENTS

1	2	3	1	2	3
Mean = 1.80	Mean = 1.96	Mean = 2.05	Mean = 2.12	Mean = 2.25	
Si/S FIP Bias			Ca/Ar FIP Bias		

- Si/S FIP bias maps indicates no change across the three observations
- Ca/Ar FIP bias maps indicates a big change in the last observation which caught the flare!

#### 5. CONCLUSION - TWO NEW INTERPRETATIONS FOR FLARES!

- Partial Ionization of Different Elements**  
First, while S is typically categorized as a high-FIP element, it has a relatively low FIP value of 10.36 eV, whereas Si, typically categorized as a low-FIP element, has a comparable FIP value of 8.15 eV. During a big heating flare, it causes an unexpected ionization of S, and the evaporation brought up Si/S in tandem, but Ar remained the same.
- Fractionation in the Low Chromosphere**  
Second, The flare studied here took place between very strong magnetic fields. This has the effect of lowering the plasma fractionation height of different elements. Under this condition, S also acts like low-FIP elements.

This unique observation created two new interpretations for us to understand the underlying physics during flares!

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UCL

1. Why Studying Composition on our Sun is Important
2. Categorising Composition - First Ionisation Potential (FIP)
3. General view of our investigation candidate - Active region 11967
4. Different results using two pairs of elements
5. Conclusion - Two new interpretations for flares!



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### Solar Photospheric Elemental Composition



## 2. CATEGORISING COMPOSITION - FIRST IONISATION POTENTIAL (FIP)

### First Ionisation Potential (FIP)

LOW-FIP (< 10eV)

Calcium | Silicon

HIGH-FIP (> 10eV)

Argon | Sulphur

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## 3. GENERAL VIEW OF OUR INVESTIGATION CANDIDATE - ACTIVE REGION 11967

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- Hosted >100 large explosions called flares, the perfect soil for Alfvén wave induced ponderomotive force!
- The instrument EIS observed the third flare, giving us a unique opportunity to study composition evolution of flares

unt  
250  
200

1.



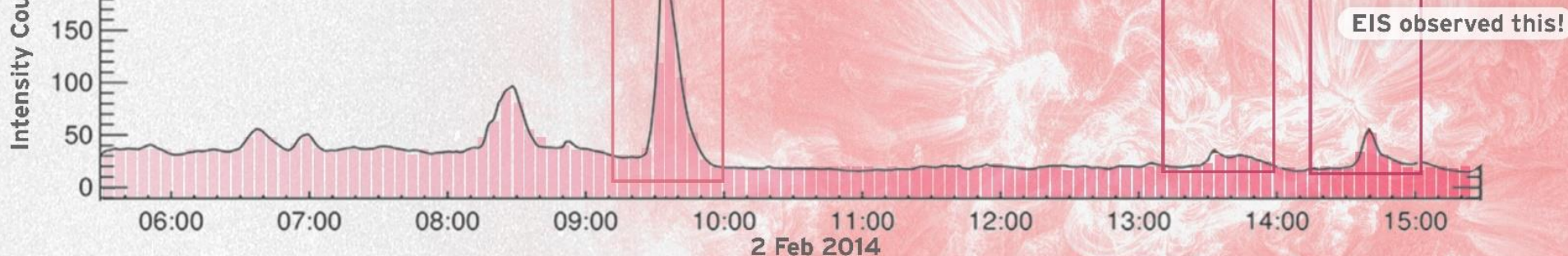
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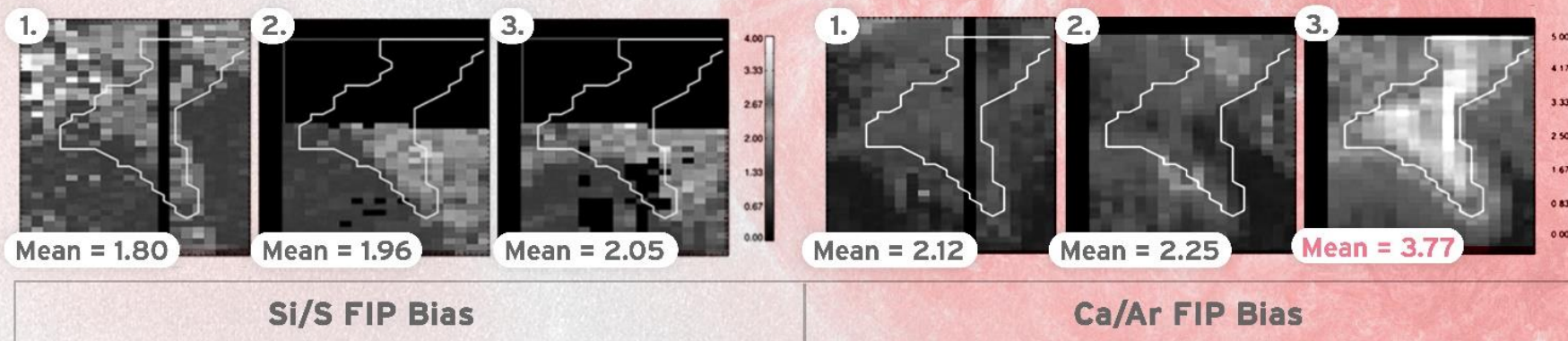
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2. Fractionation in the Low Chromosphere

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