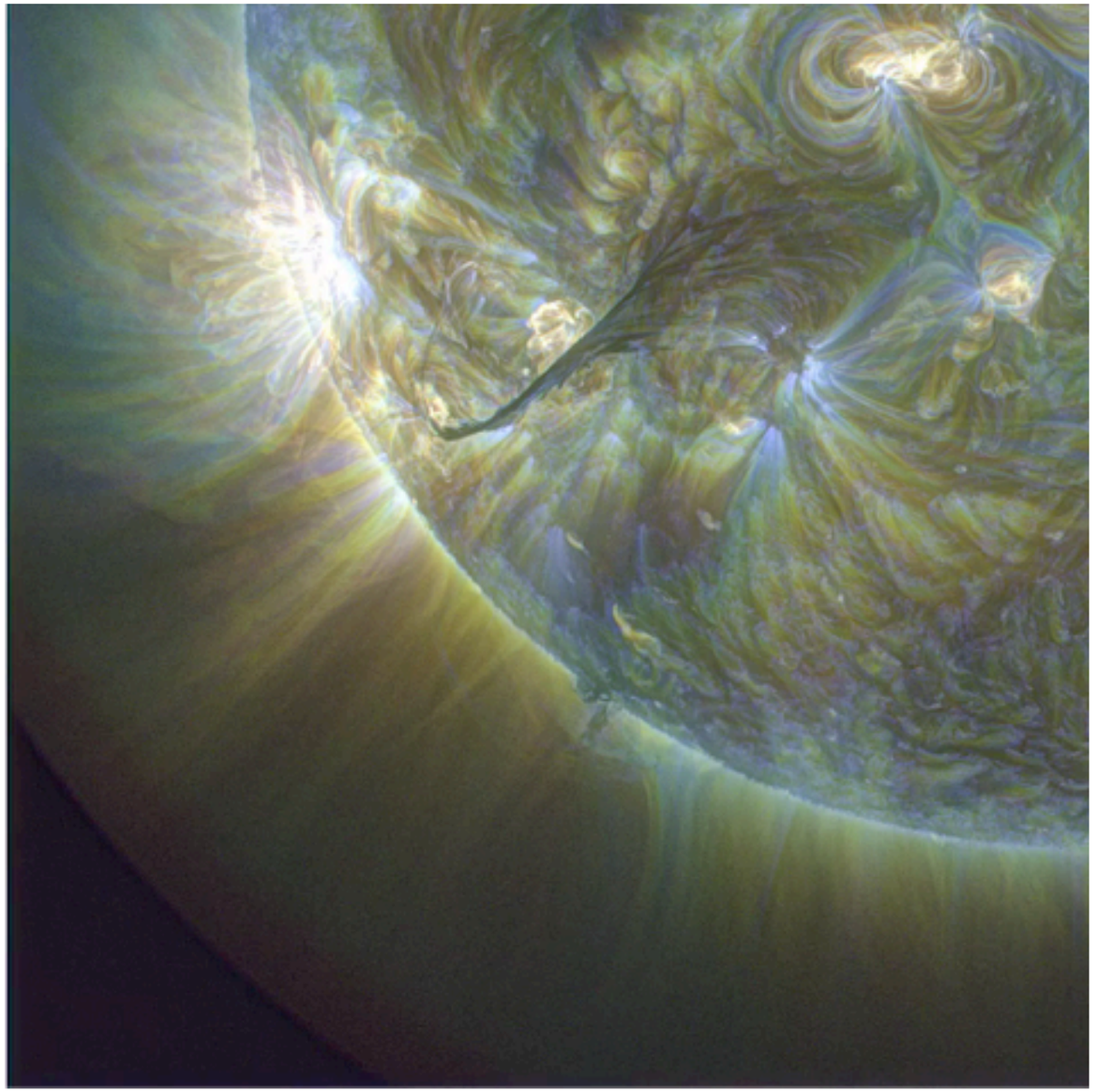
The topology of supersonic up-flows in a filament eruption

High-speed Flows in a Bright Thread

David Williams[1] • **Deb Baker**[1] • **Lucie Green**[1,2] • **David Long**[1]
Lidia van Driel-Gesztelyi[1,3,4] • **Iain Hannah**[2,5]

[1]University College London • [2]Royal Society University Research Fellow
[3]Observatoire de Paris, Meudon • [4]Konkoly Observatory
[5]University of Glasgow

Filament eruptions & EIS



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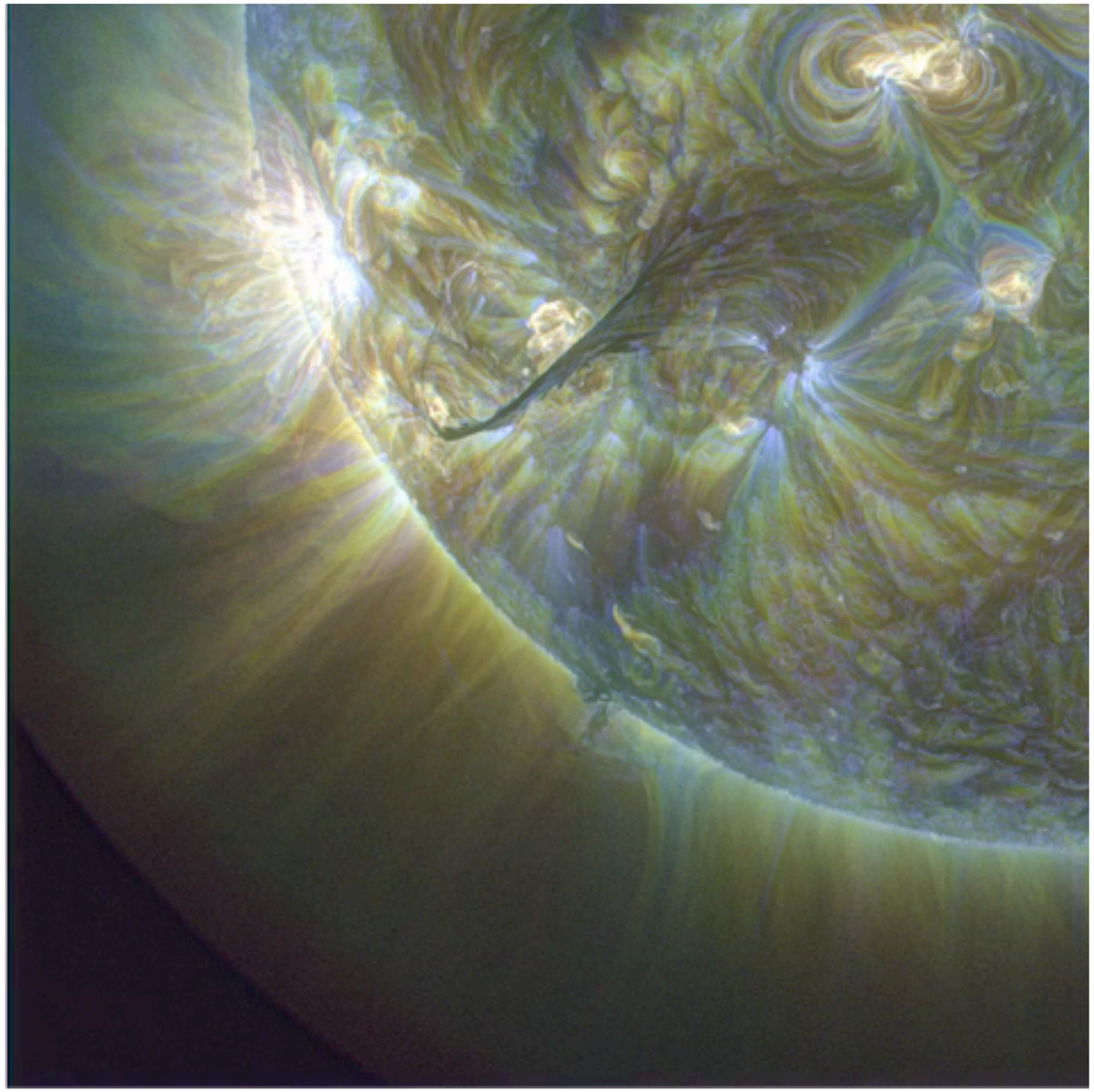

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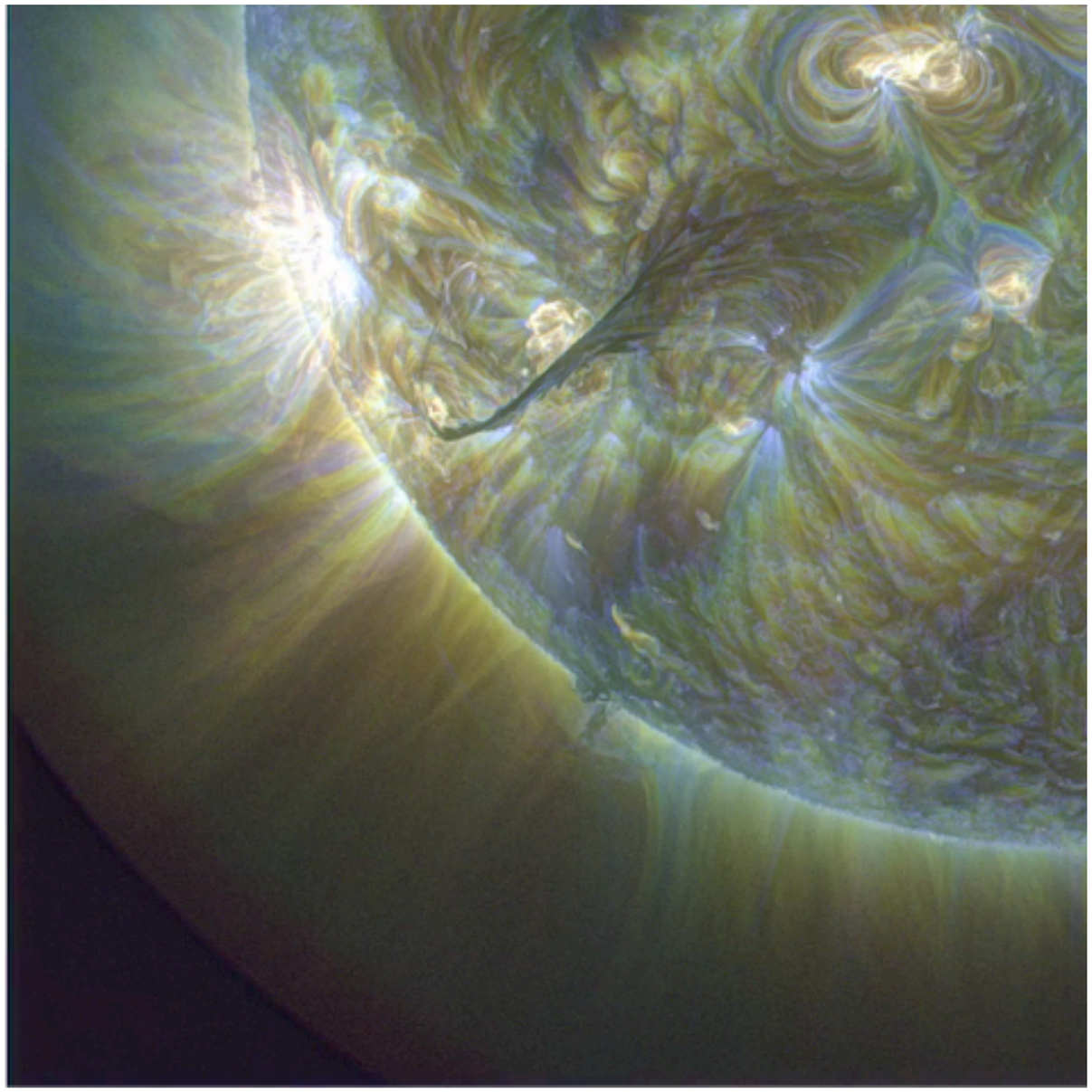
  - **morphology**



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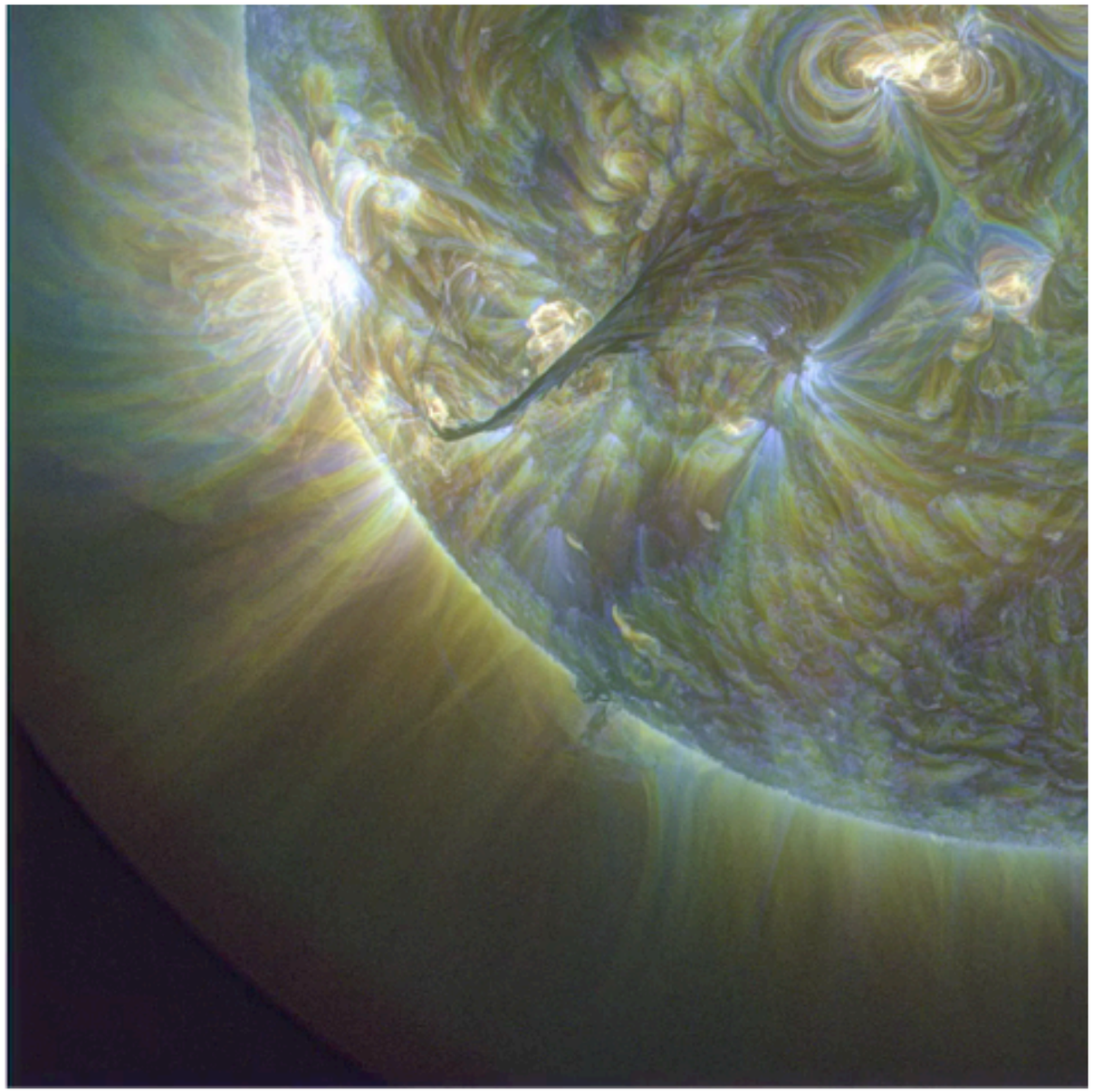
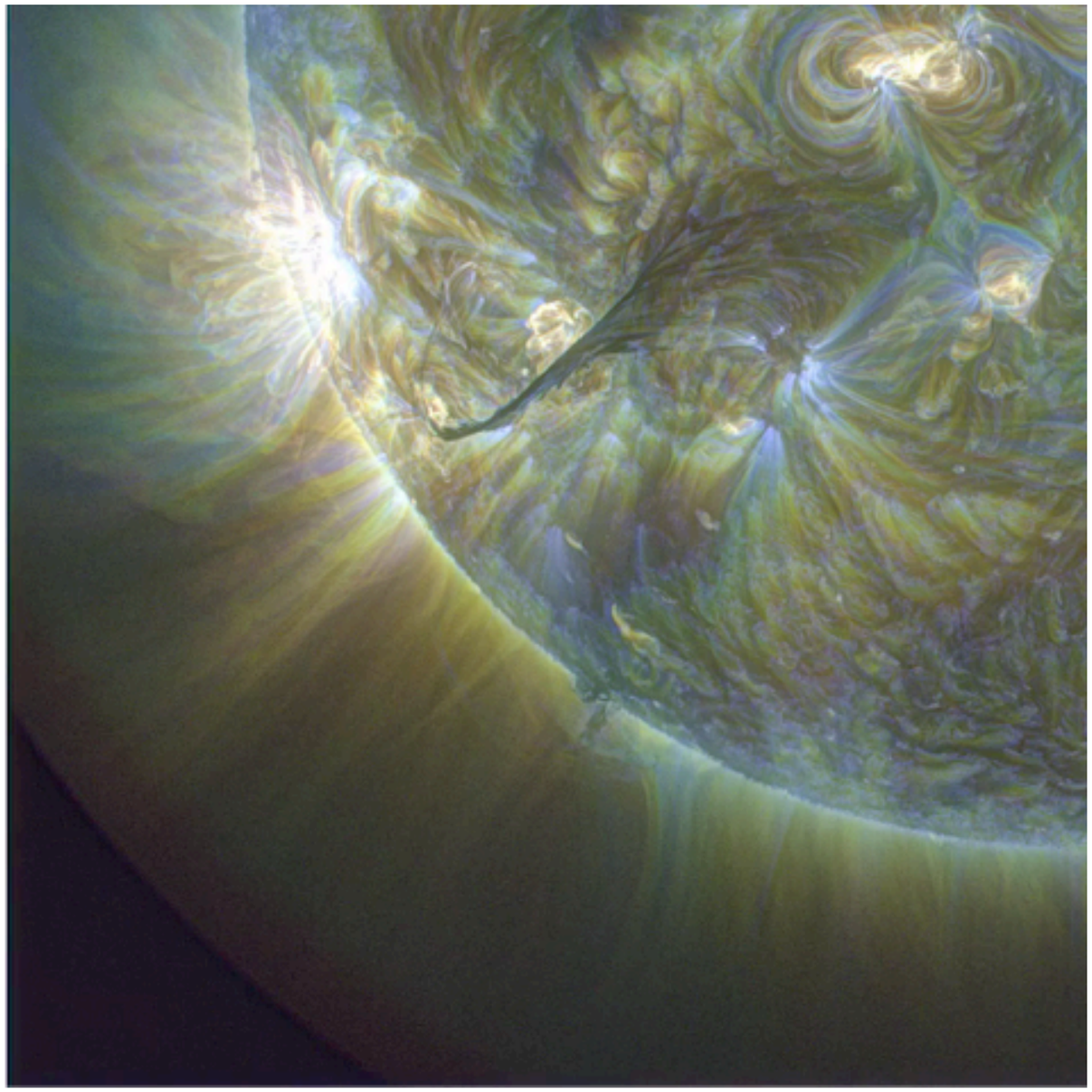
  - other diagnostics



Filament eruptions & EIS

- Observed by AIA
  - **morphology**
- Observed by EIS
  - **velocity**
  - other diagnostics
- Probing dynamics
  - where eruption crosses EIS slit



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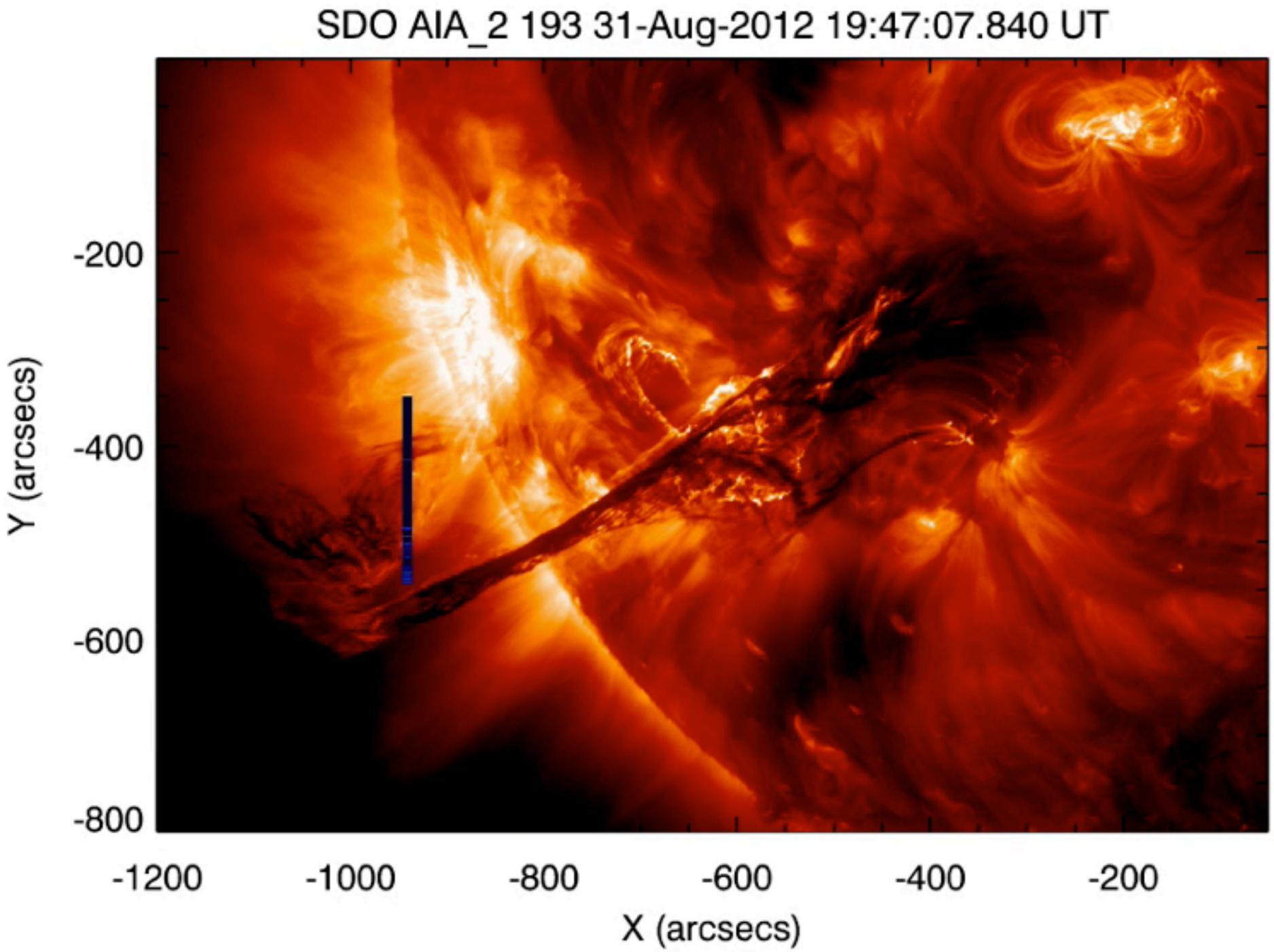
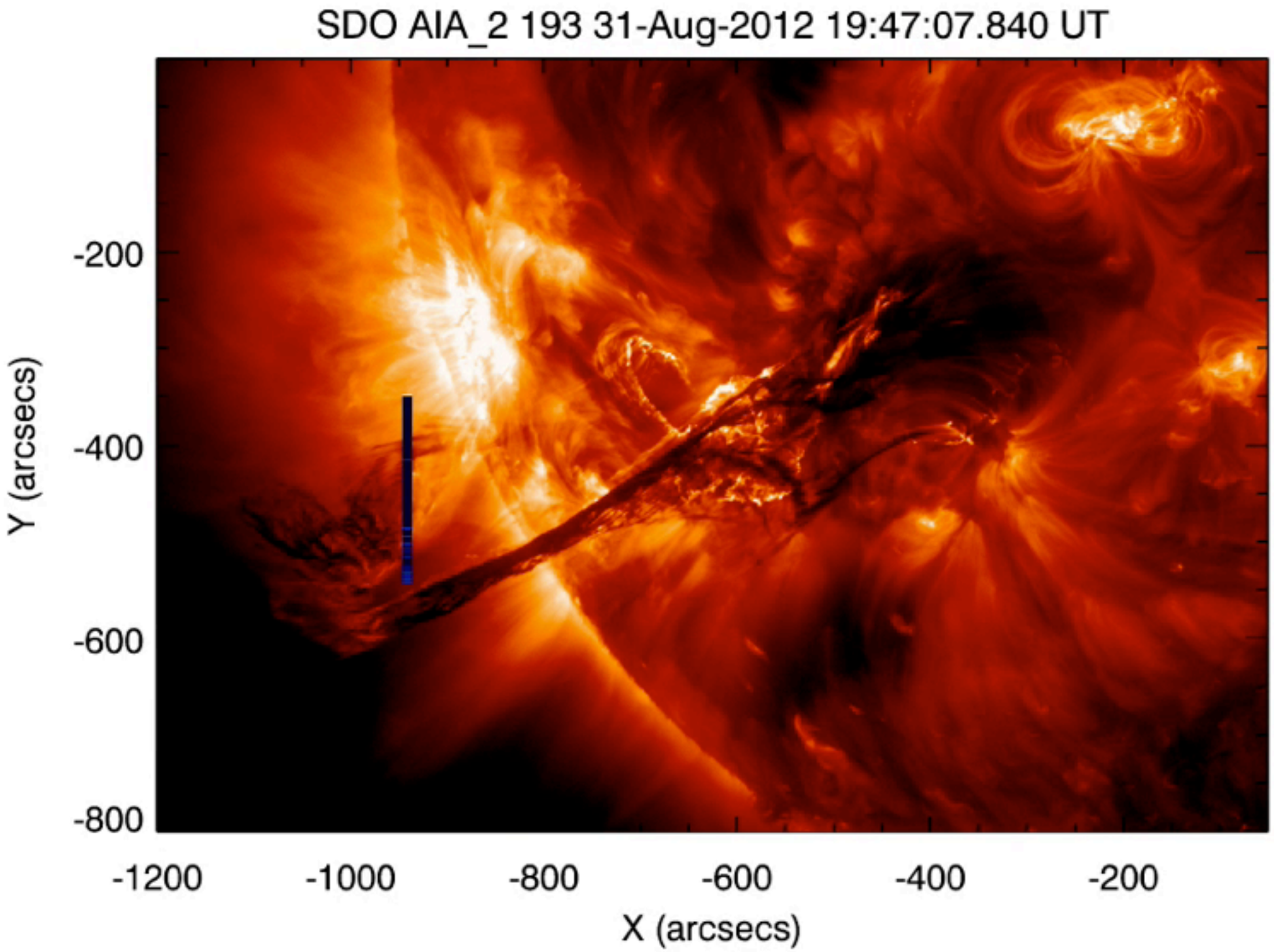
- Spacecraft observing schedules of order days
- Eruption pre-cursors on much shorter timescales


SDO AIA_2 193 31-Aug-2012 19:47:07.840 UT
-200
-400
-600
-800
Y (arcsecs)
-1200
-1000
-800
-600
-400
-200
X (arcsecs)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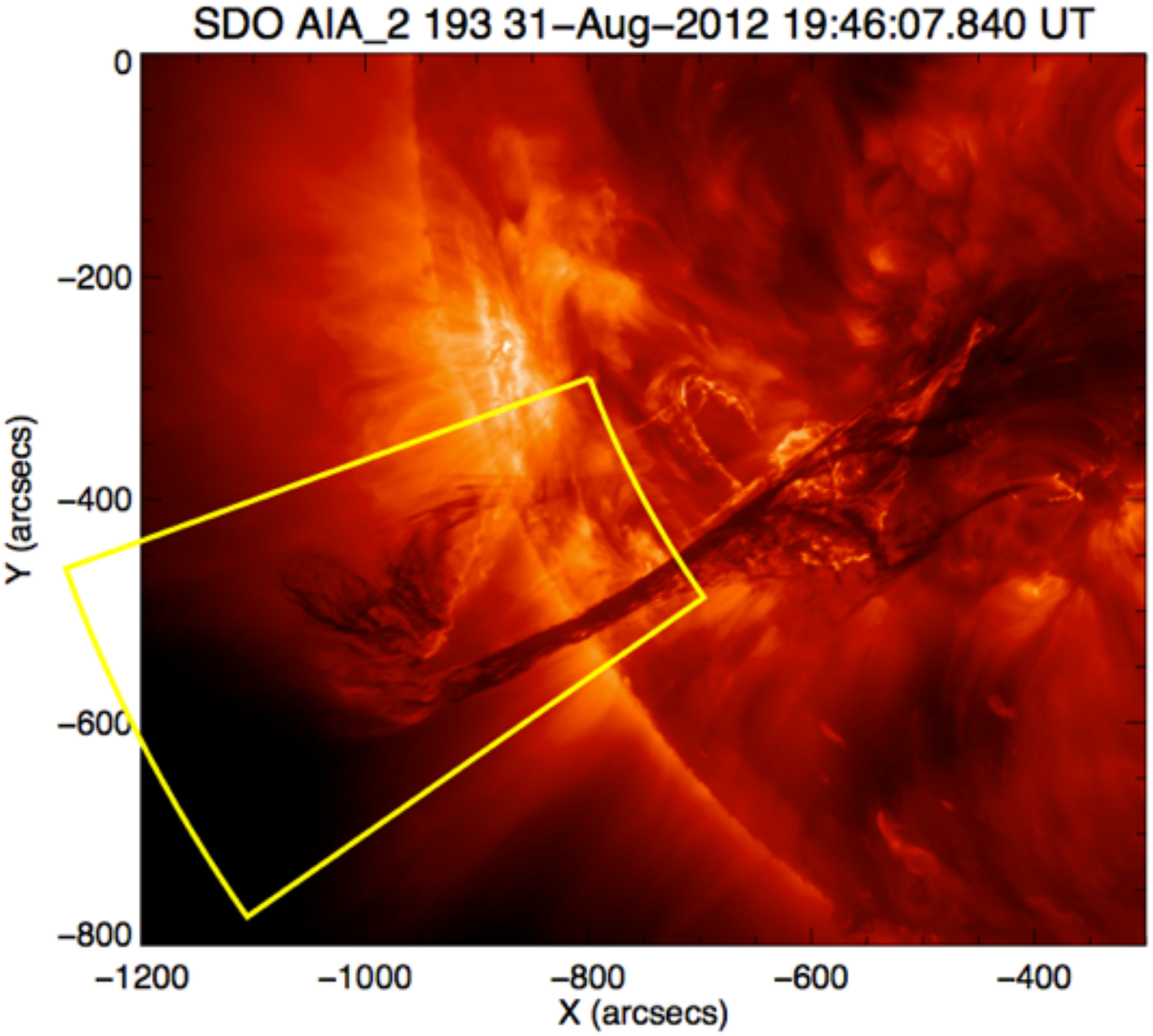
Eruption profile near Sun



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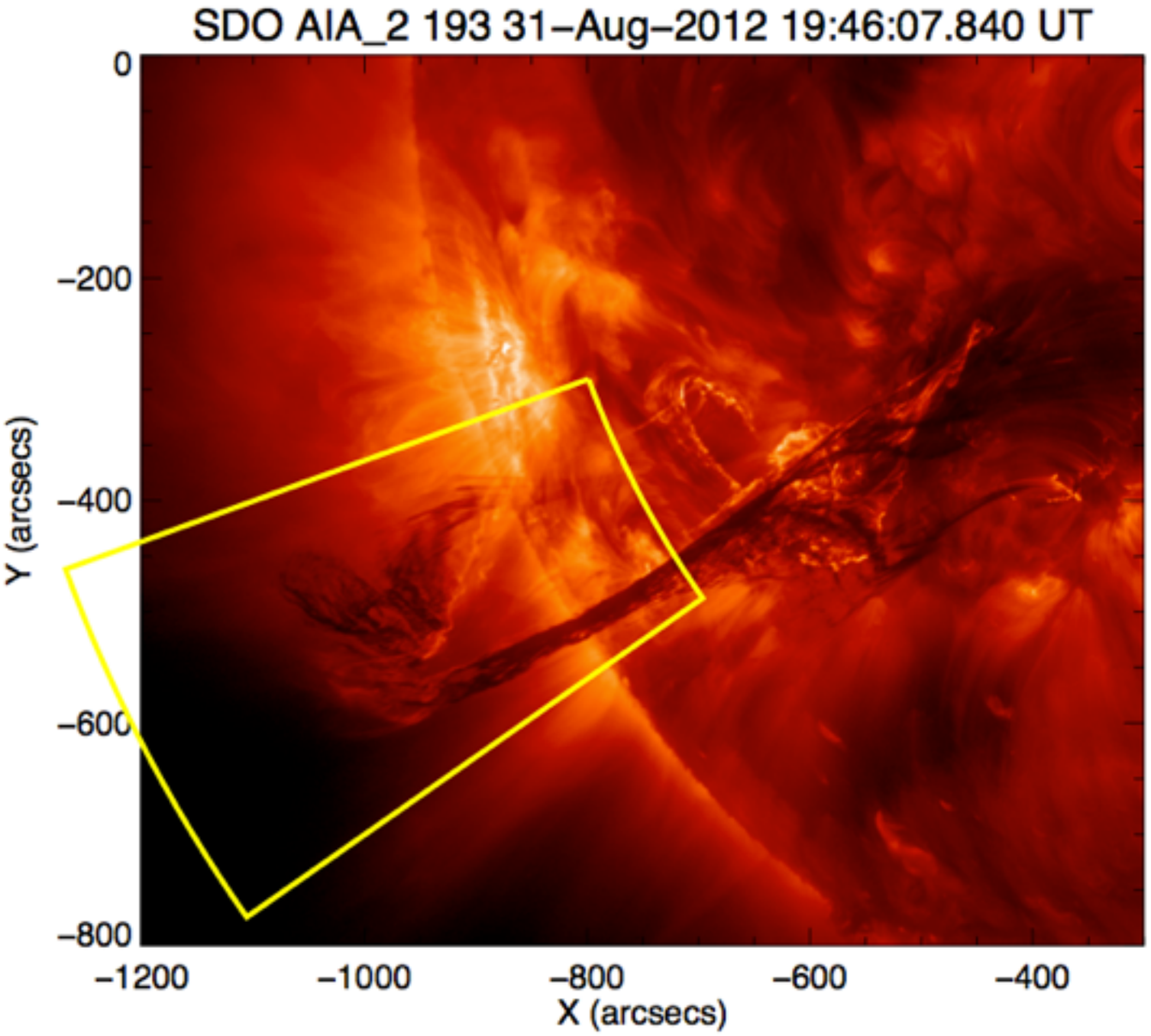

- Track radial motion of filament

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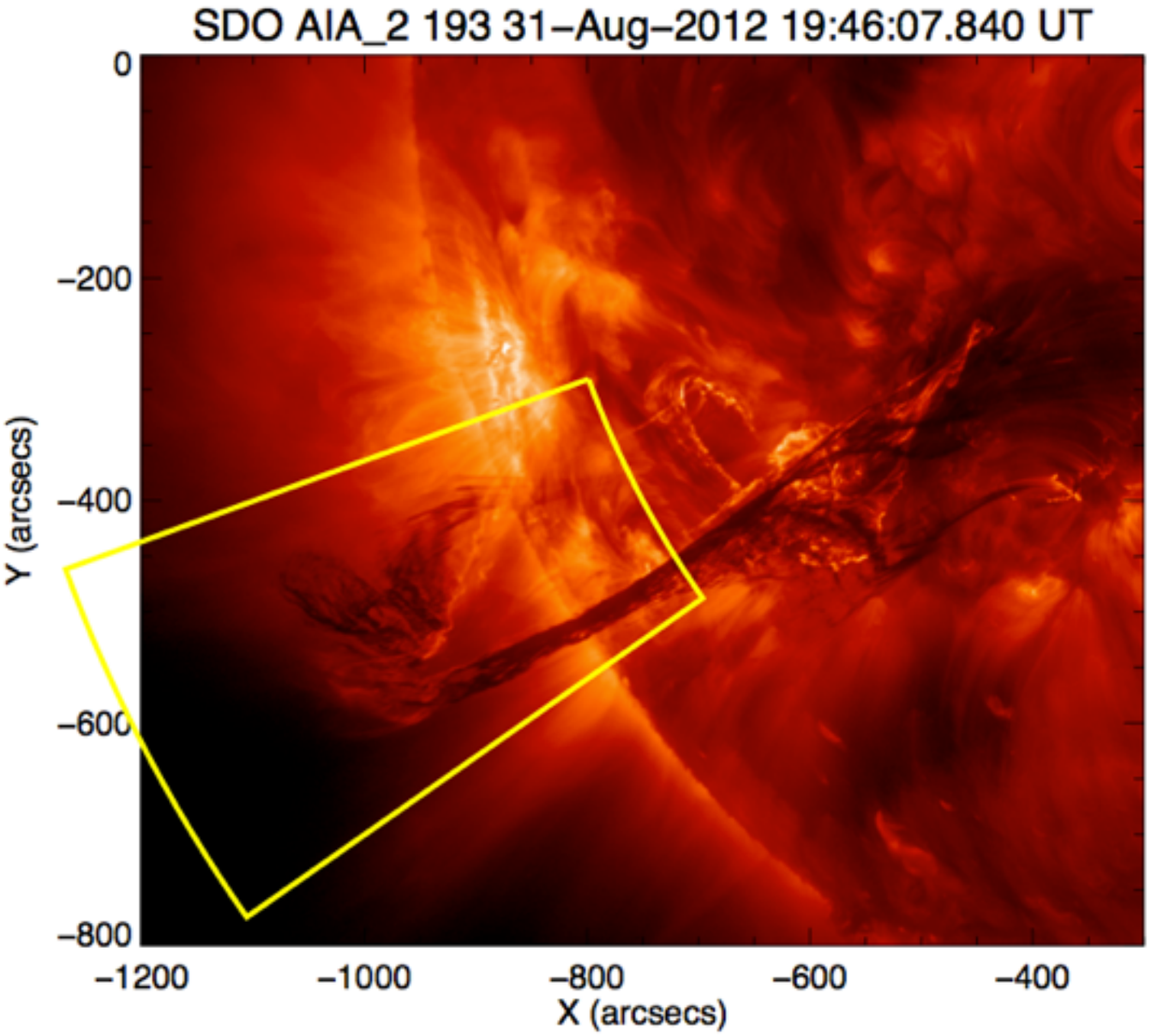

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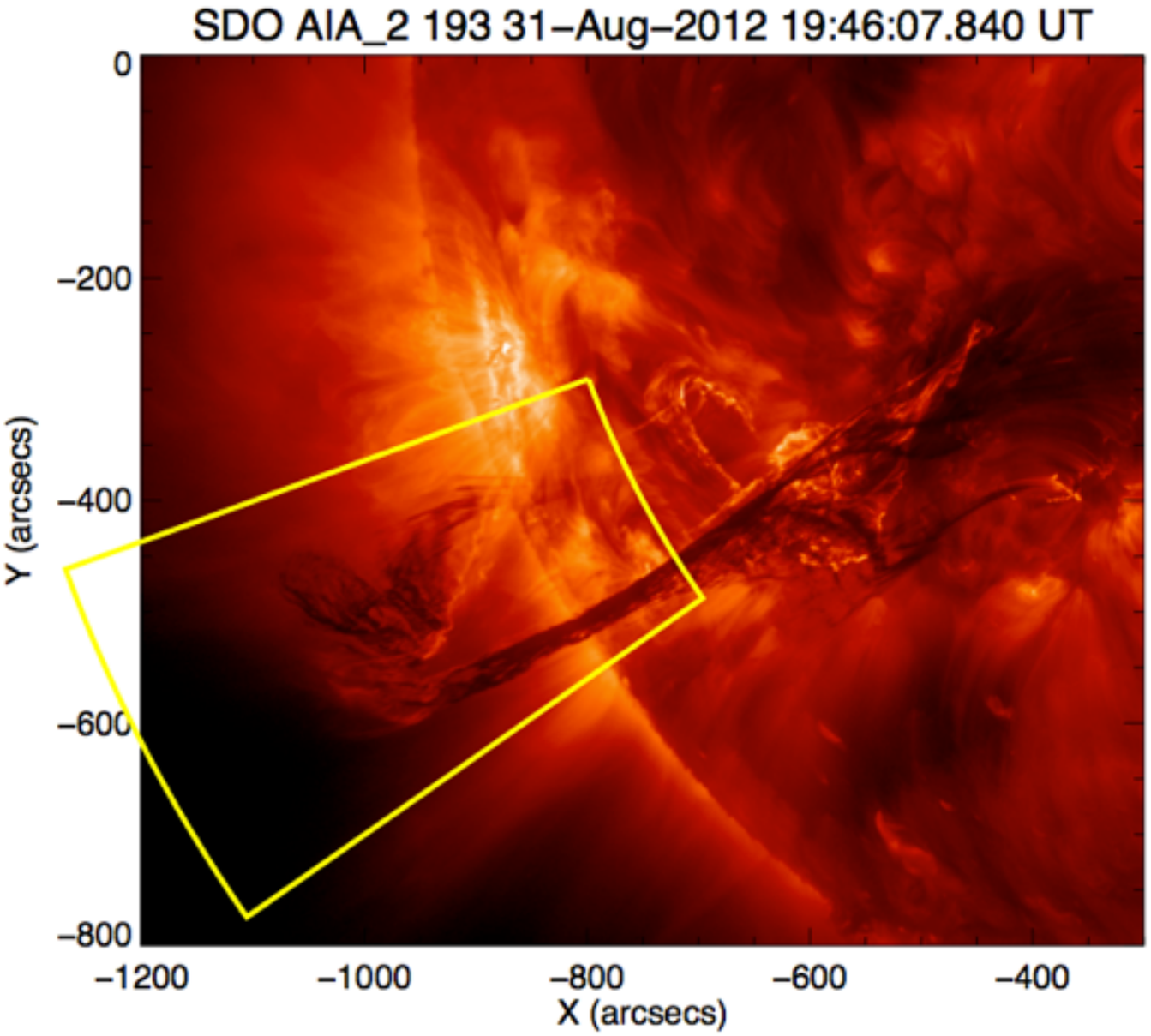

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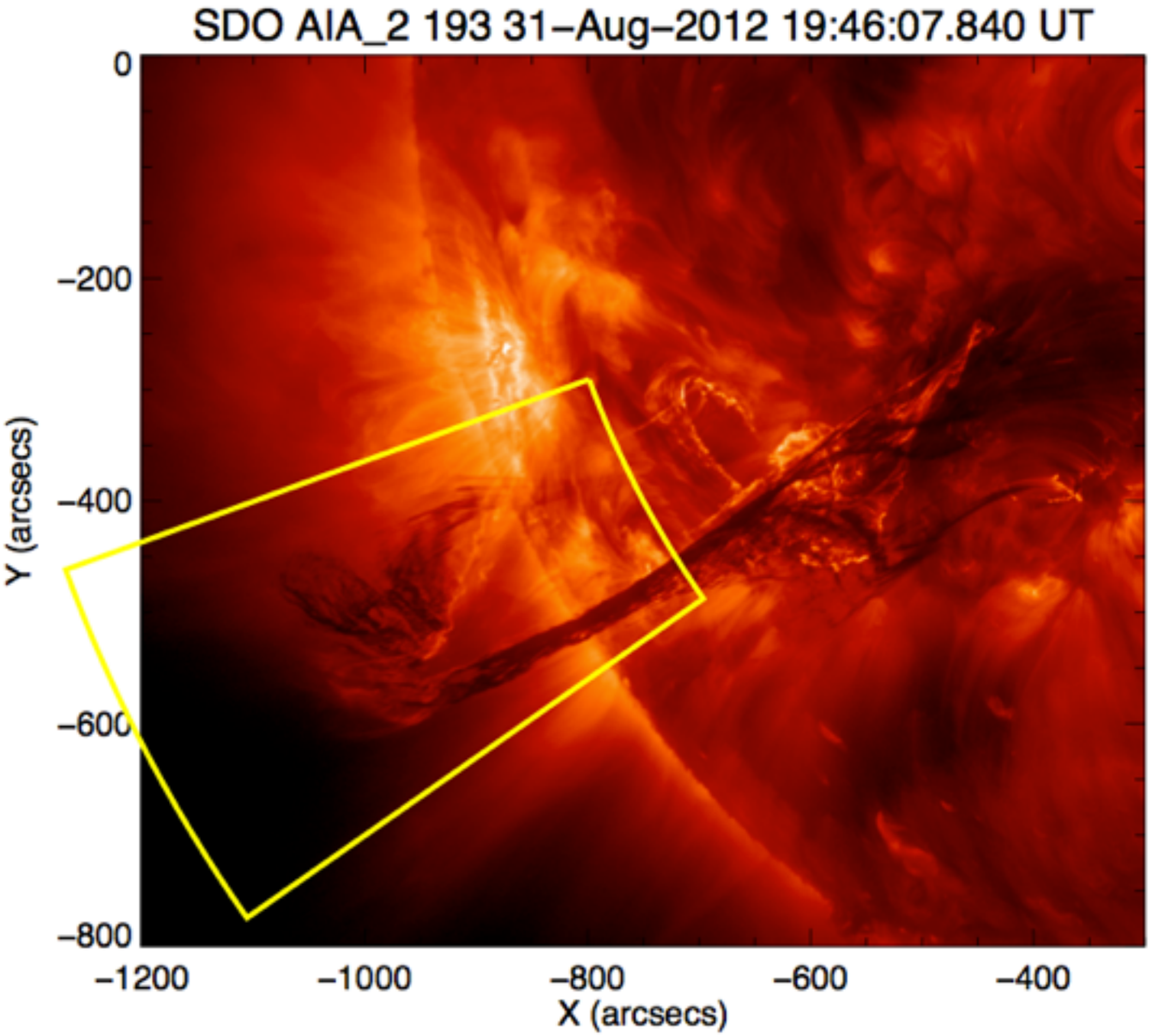

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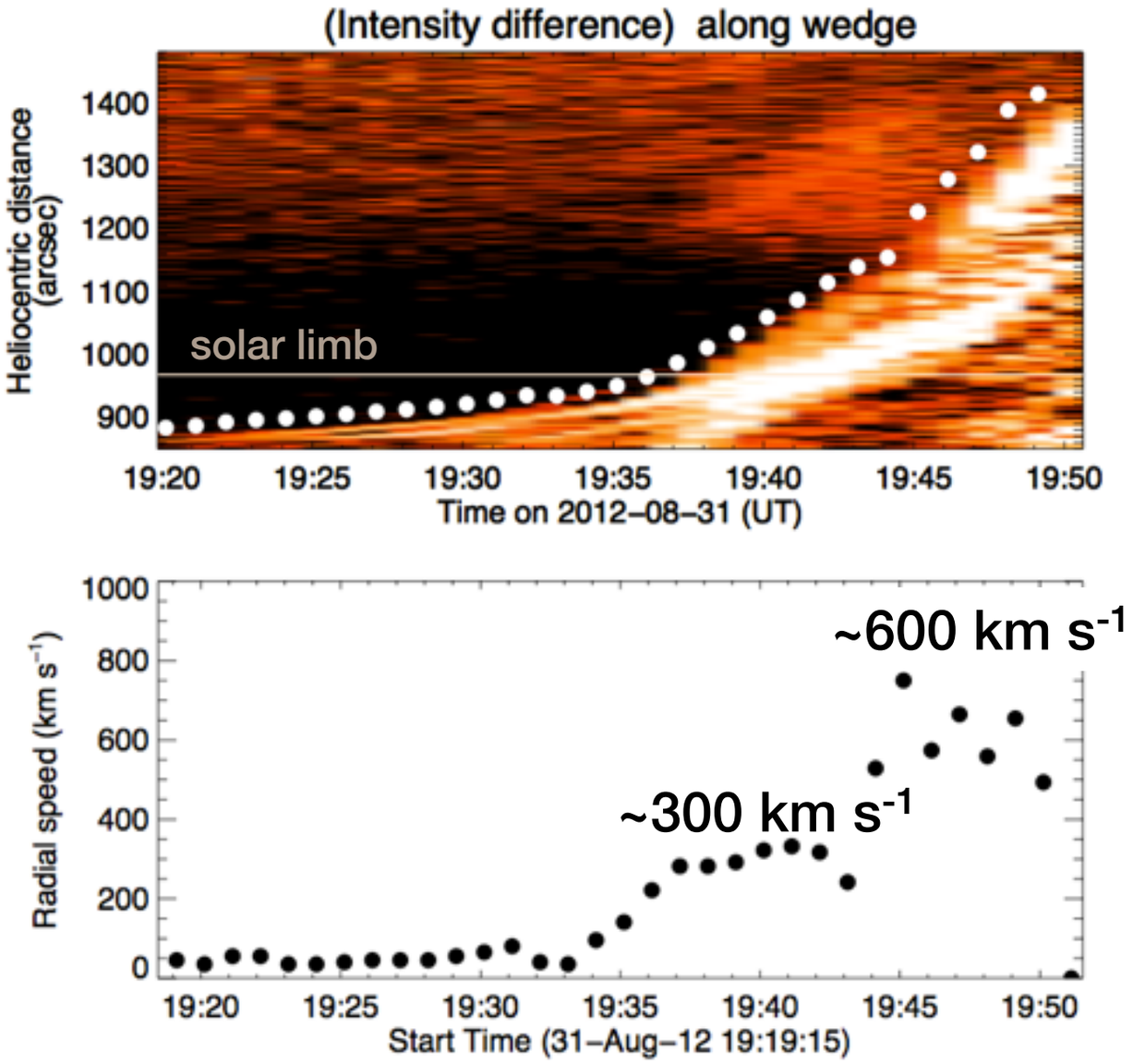

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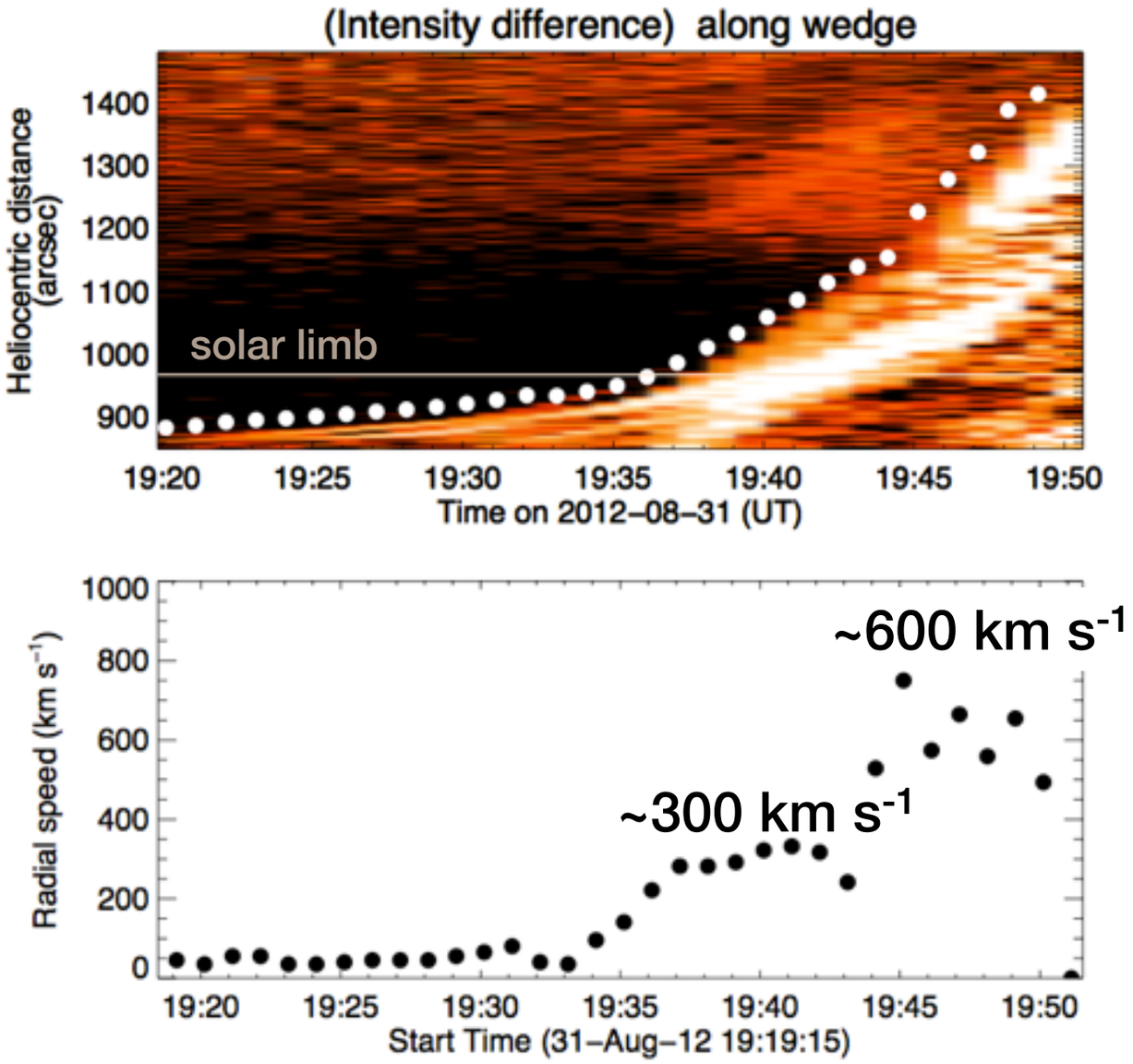

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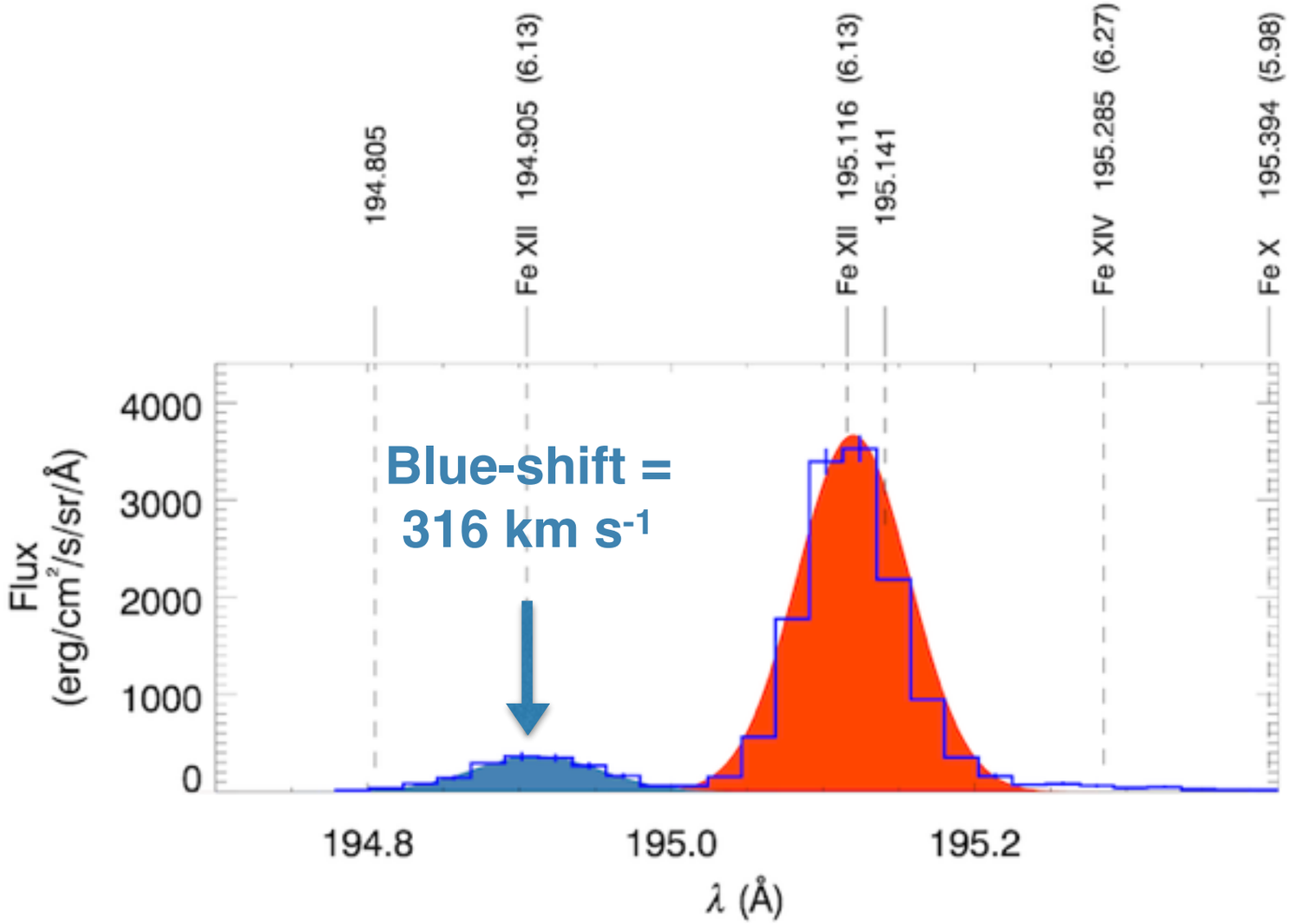
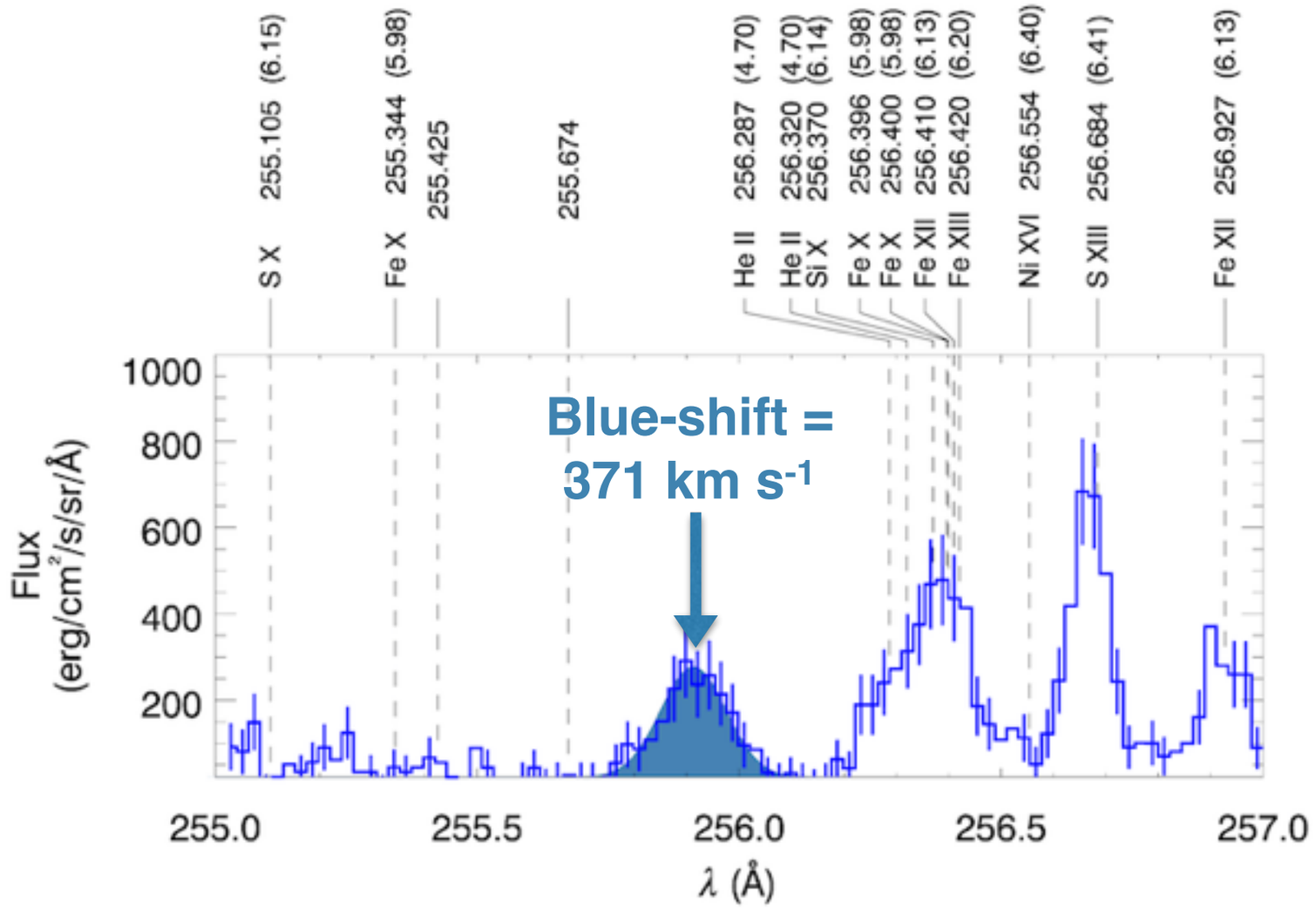
  - Sum absolute differences from background
  - Integrate over 15° azimuth
  - Gradient-based tracking of front
  - Shown as white circles

Spectra along filament: Fe XII



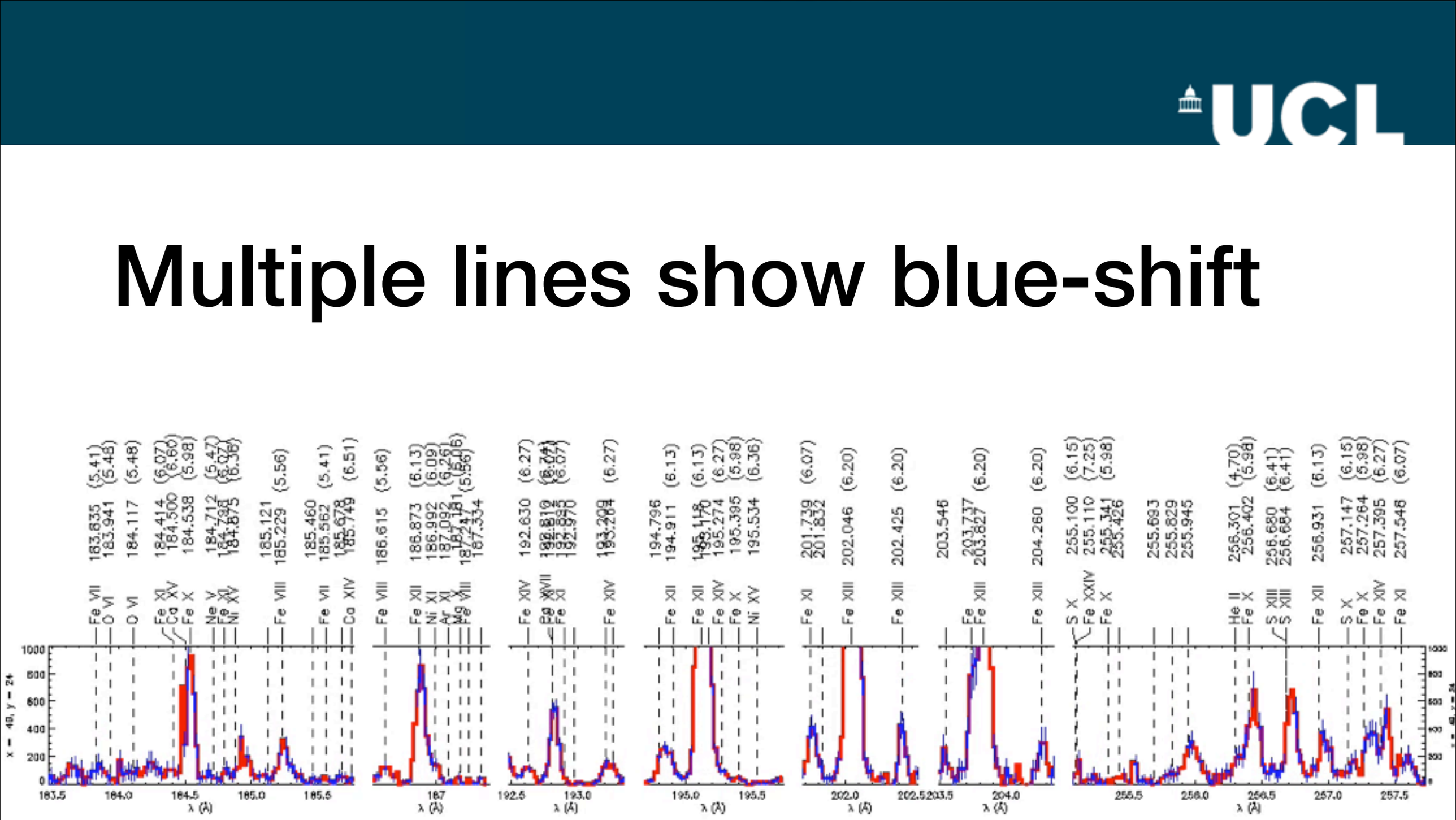
- 195.12 Å
- Rest component from foreground/background is shown in orange.
- No other strong lines in the spectrum where it shifts to: clean identification
  - λ194.9 is a red herring
- Supersonic

Spectra along filament: He II



- 256.32 Å
- Only Doppler-shifted component is fitted here
- Clean area of spectrum
- In all cases, pattern persists for > 10 min where thread crosses slit

Multiple lines show blue-shift



Selecting spectrum from increasingly higher points along slit as the movie plays

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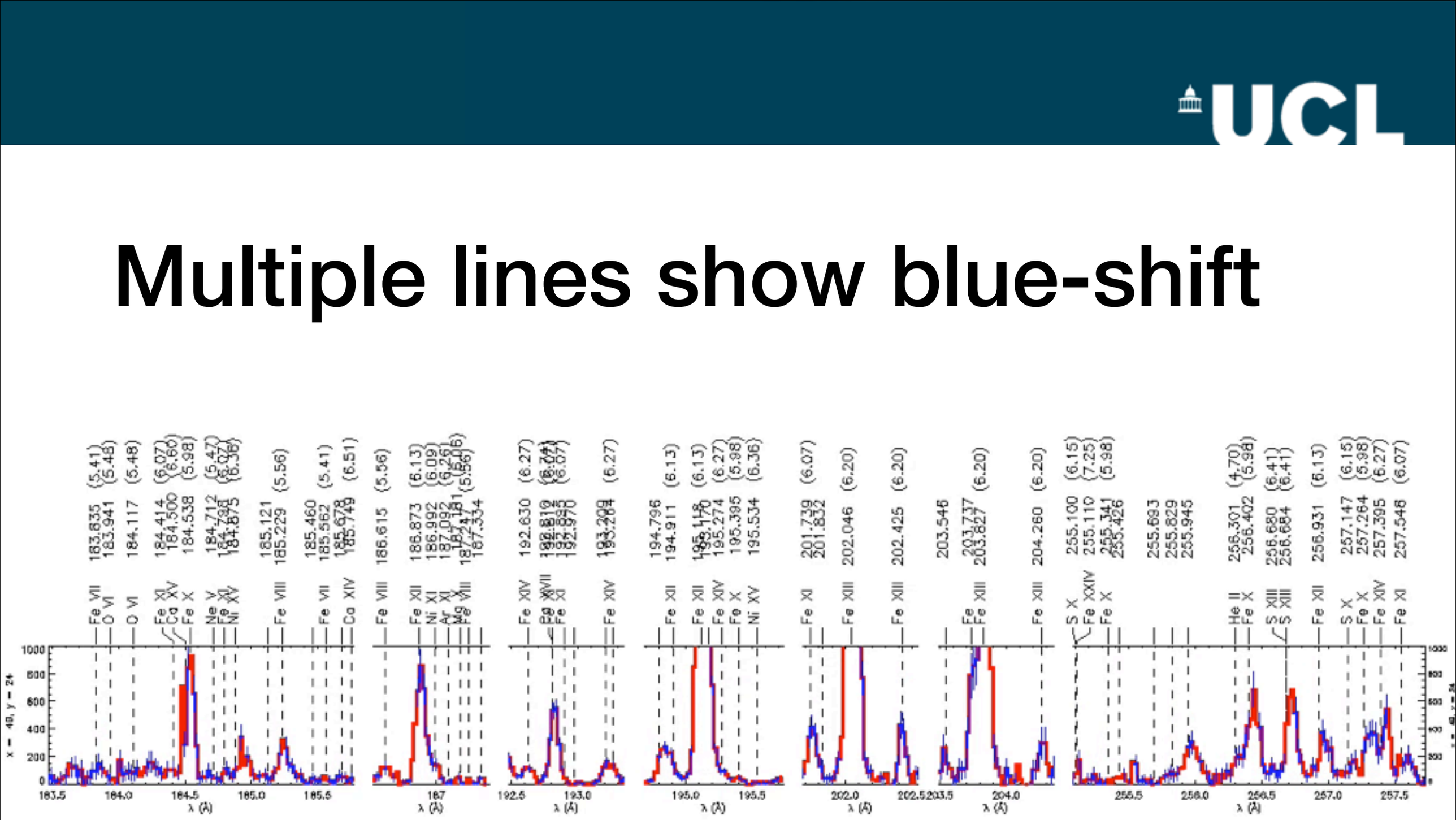

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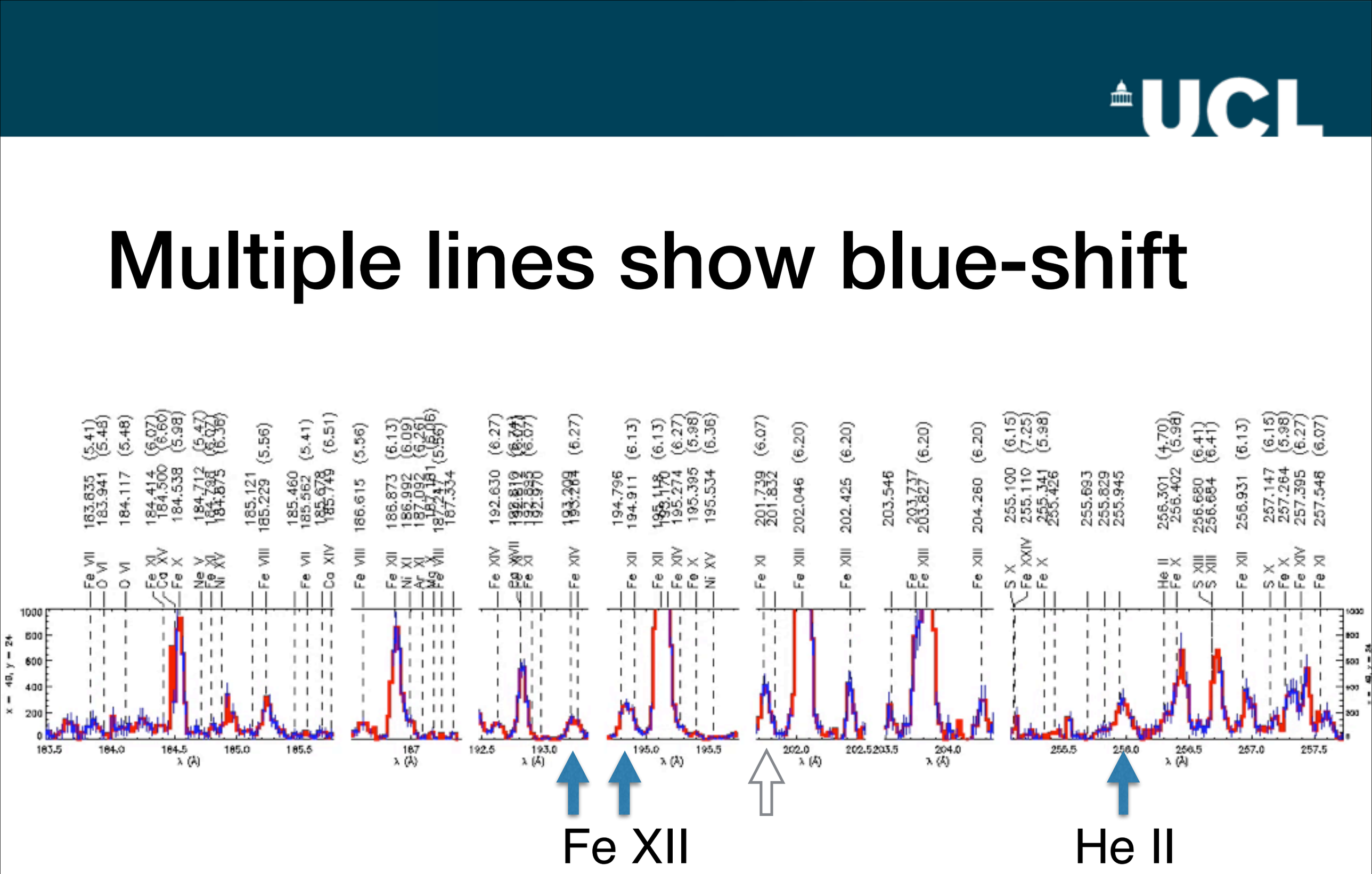

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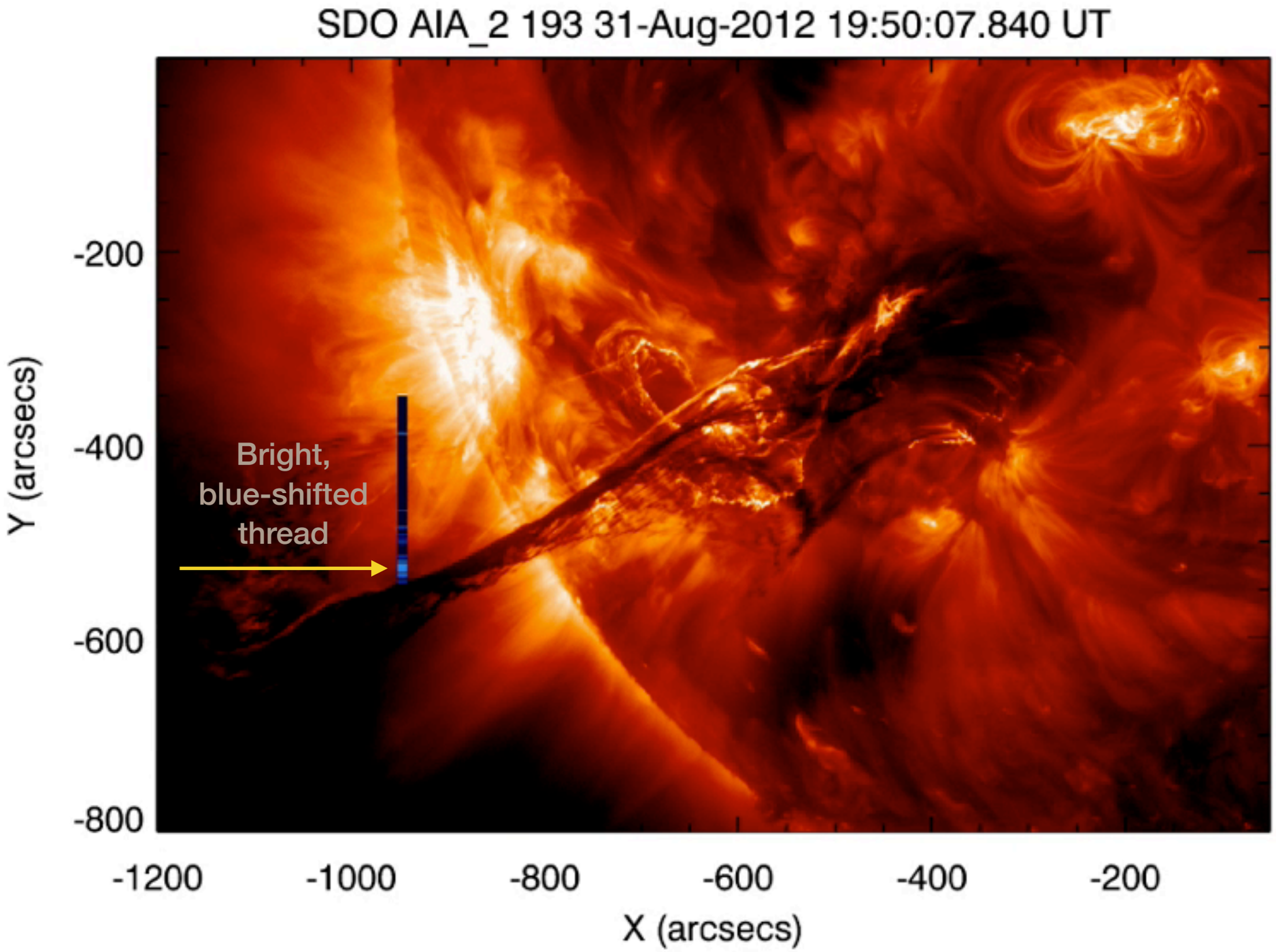
SDO AIA_2 193 31-Aug-2012 19:50:07.840 UT
Bright, blue-shifted thread
-200
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Y (arcsecs)
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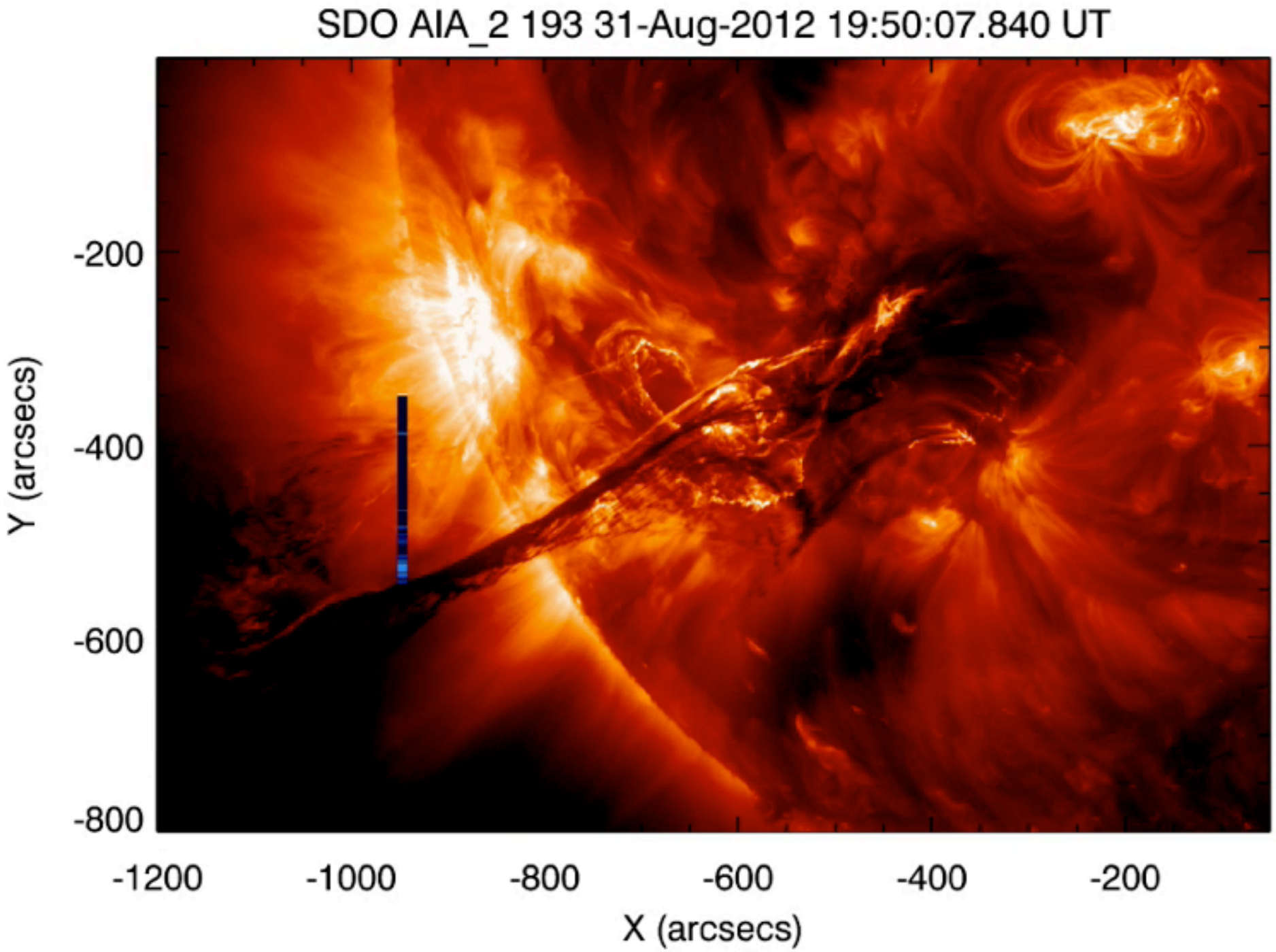
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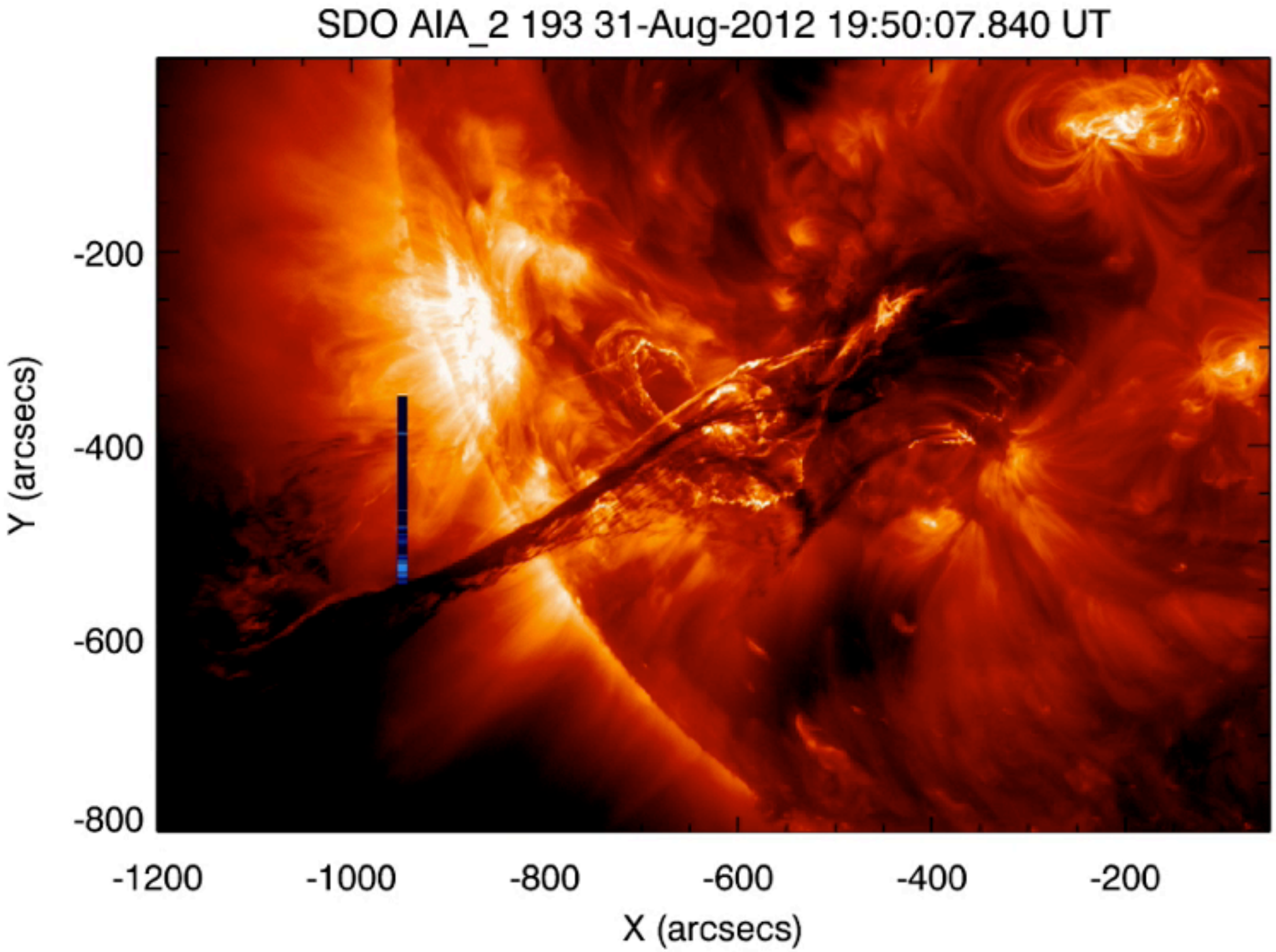
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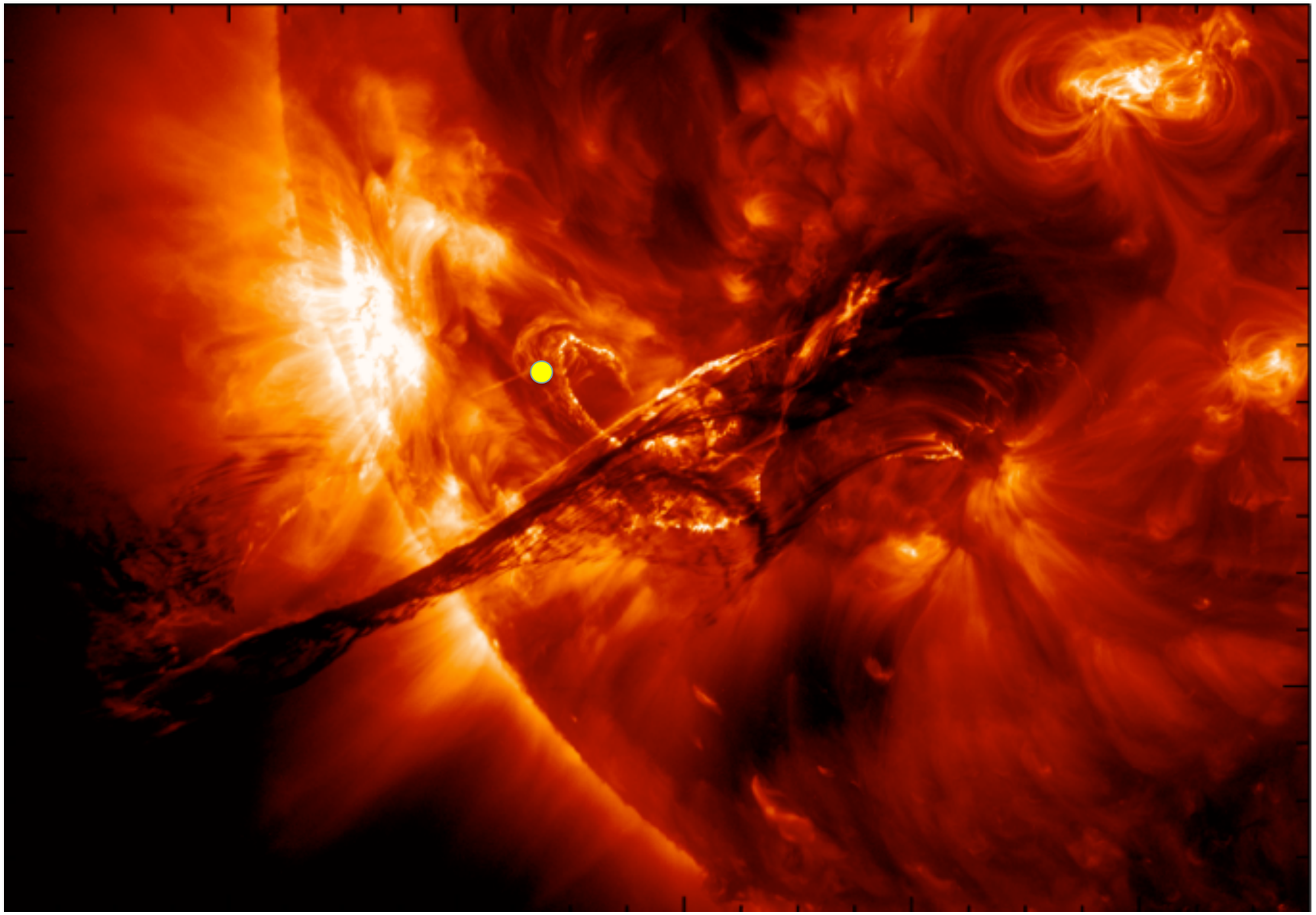
Thread outline



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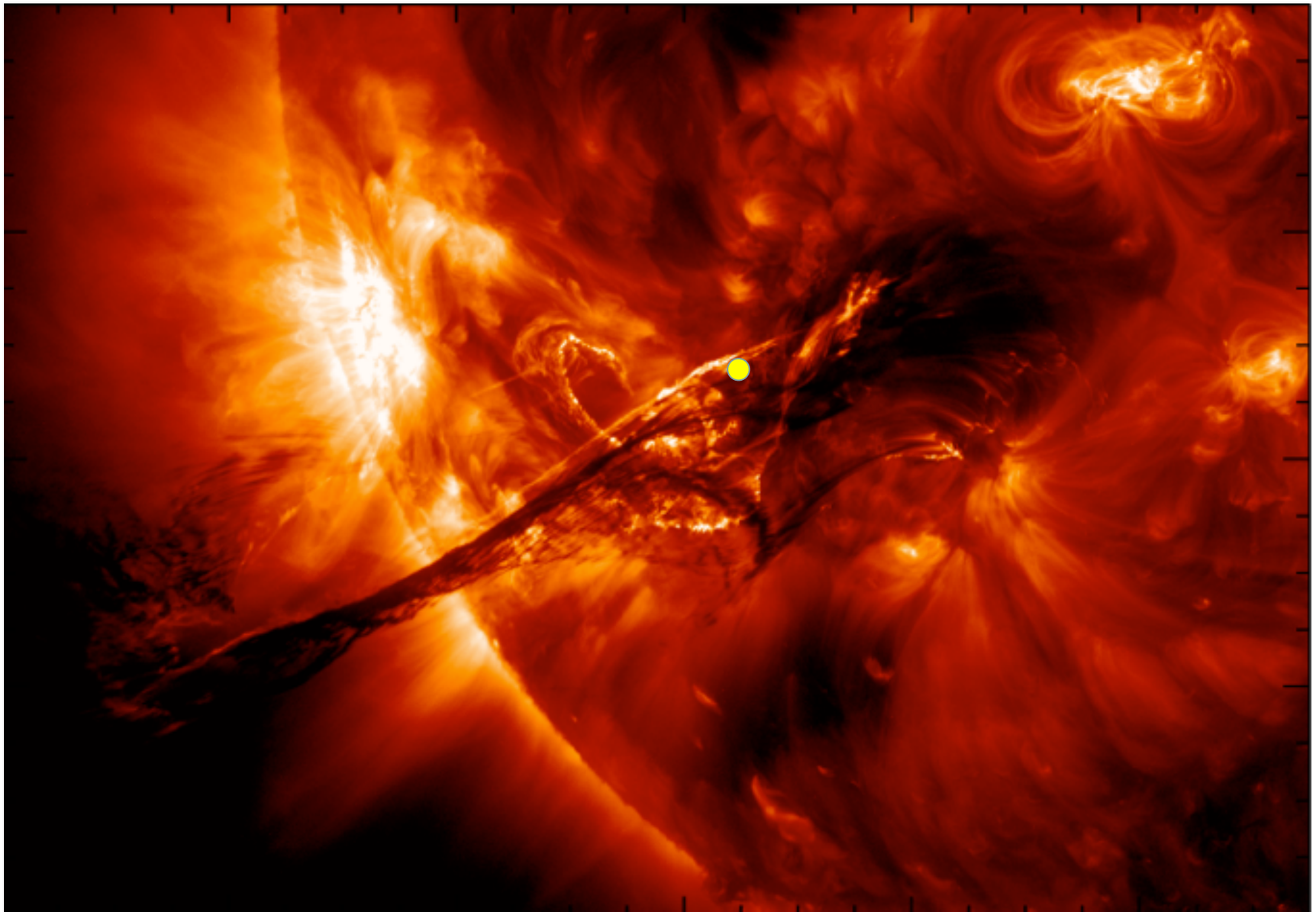

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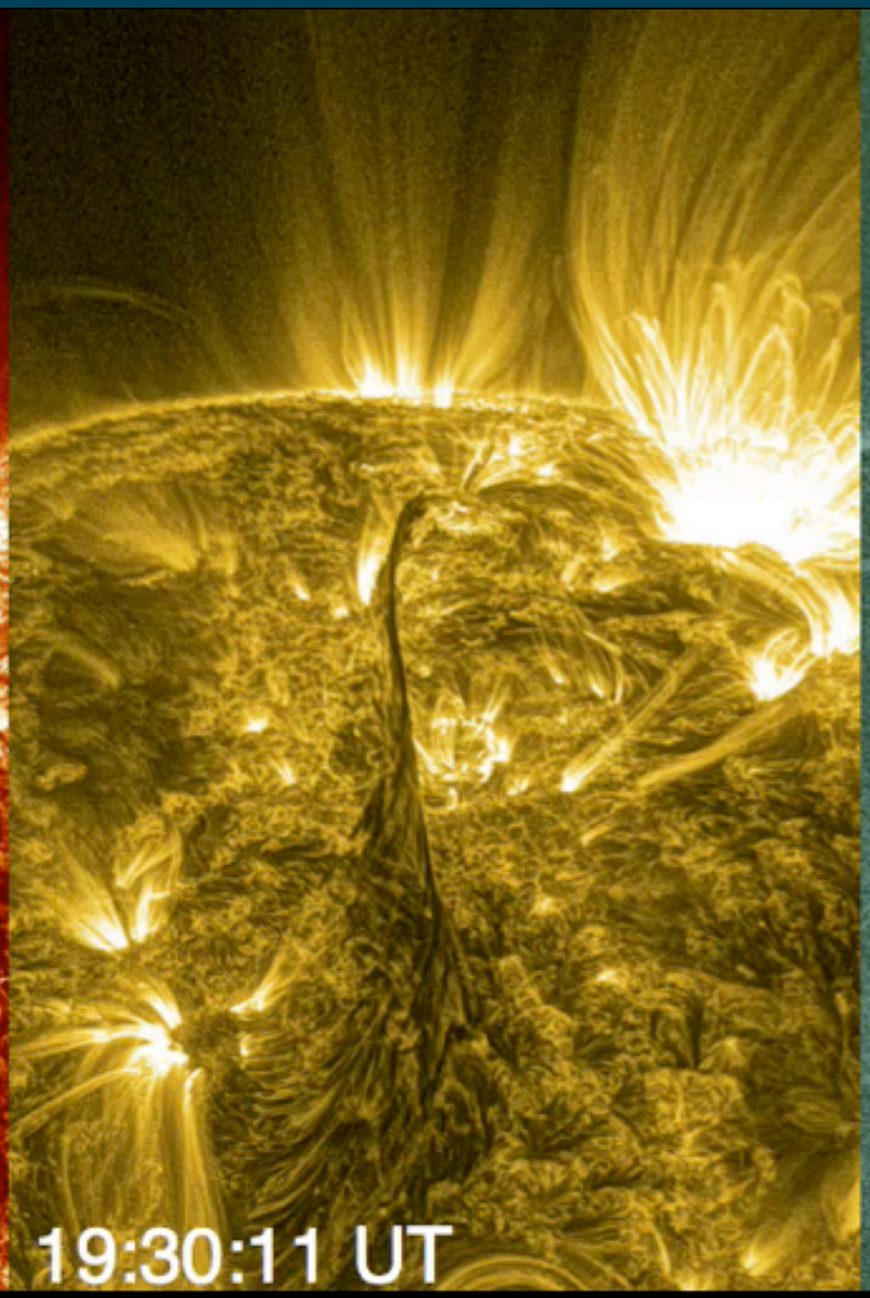

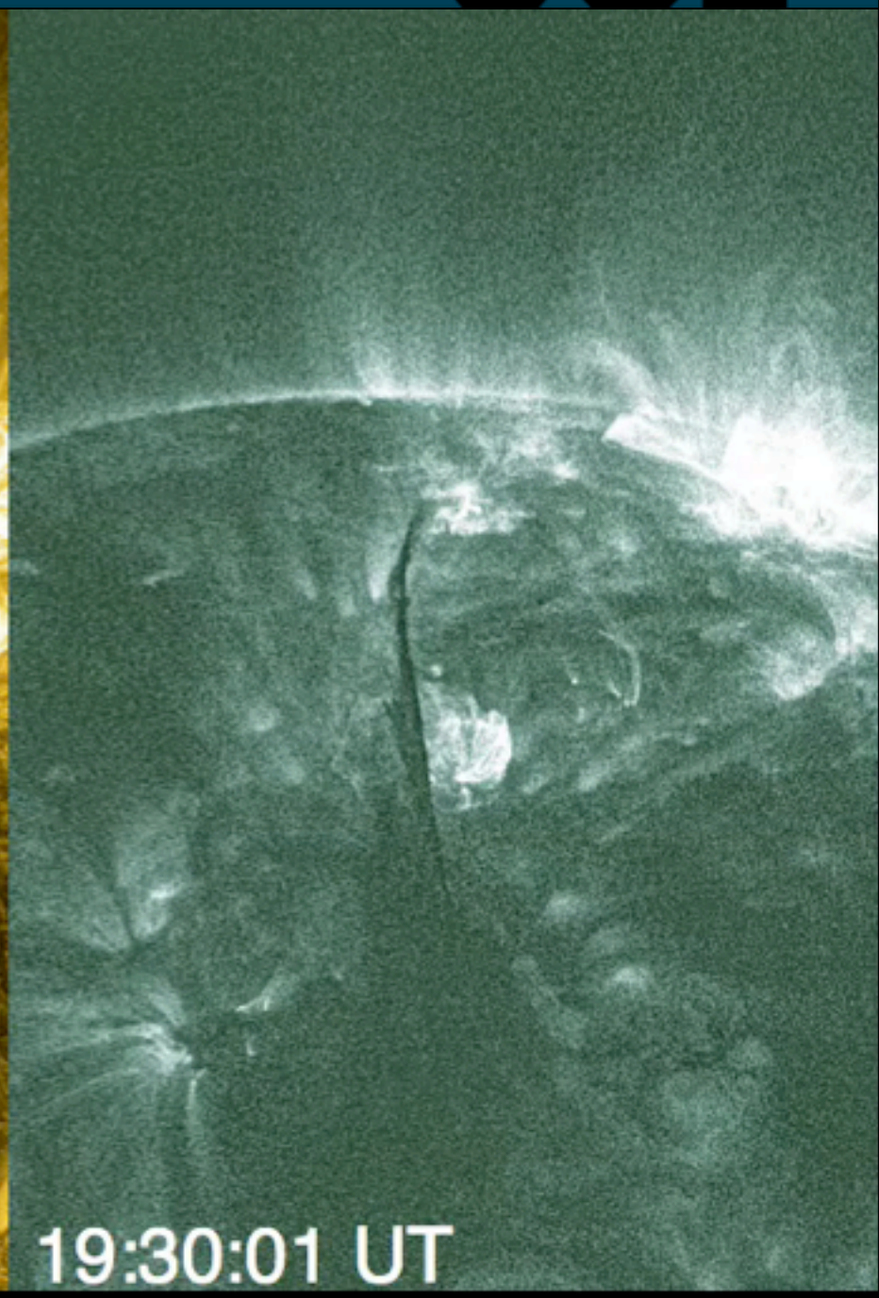

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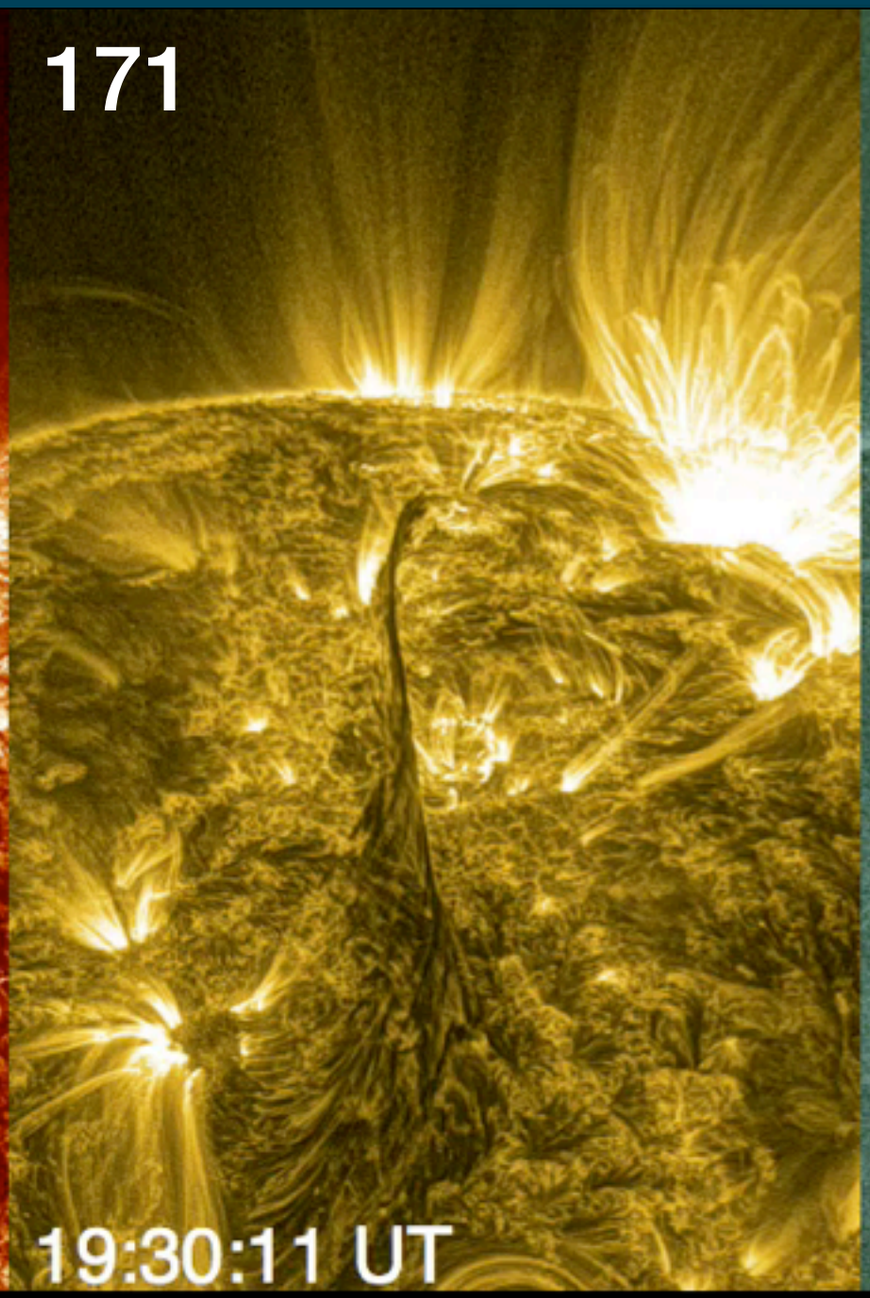

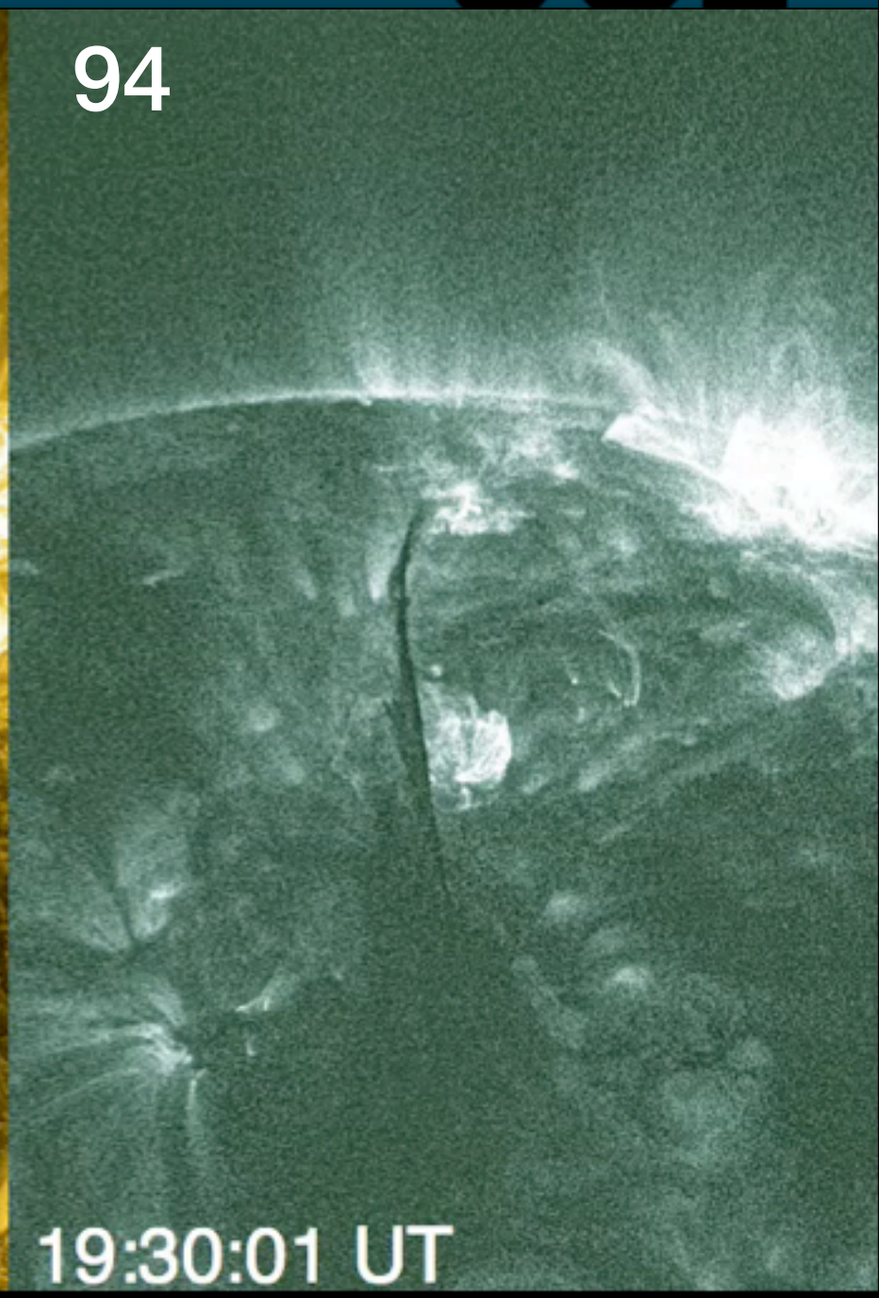

Flare ribbons & topology

Démoulin, Priest & Lonie (1996)

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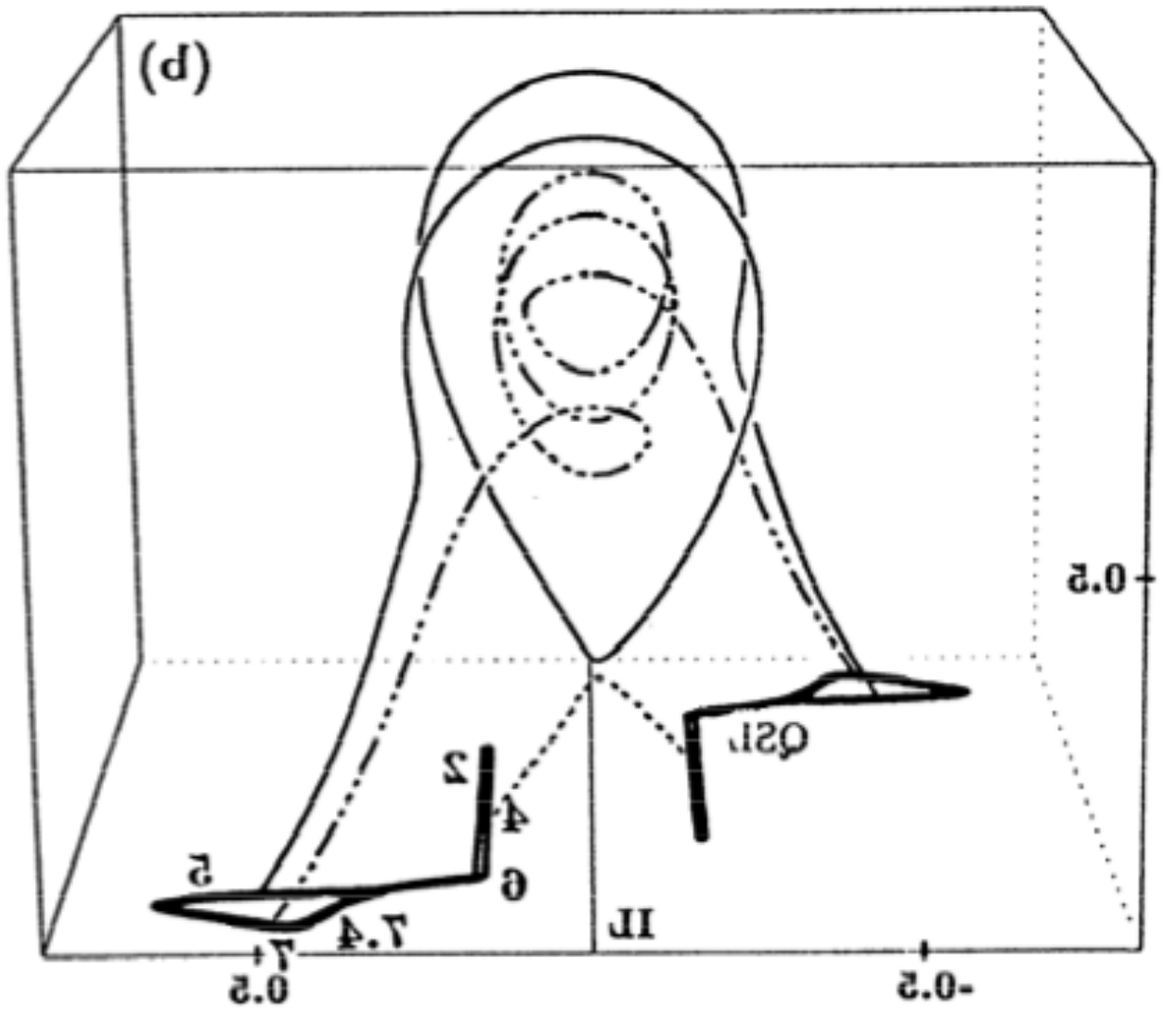

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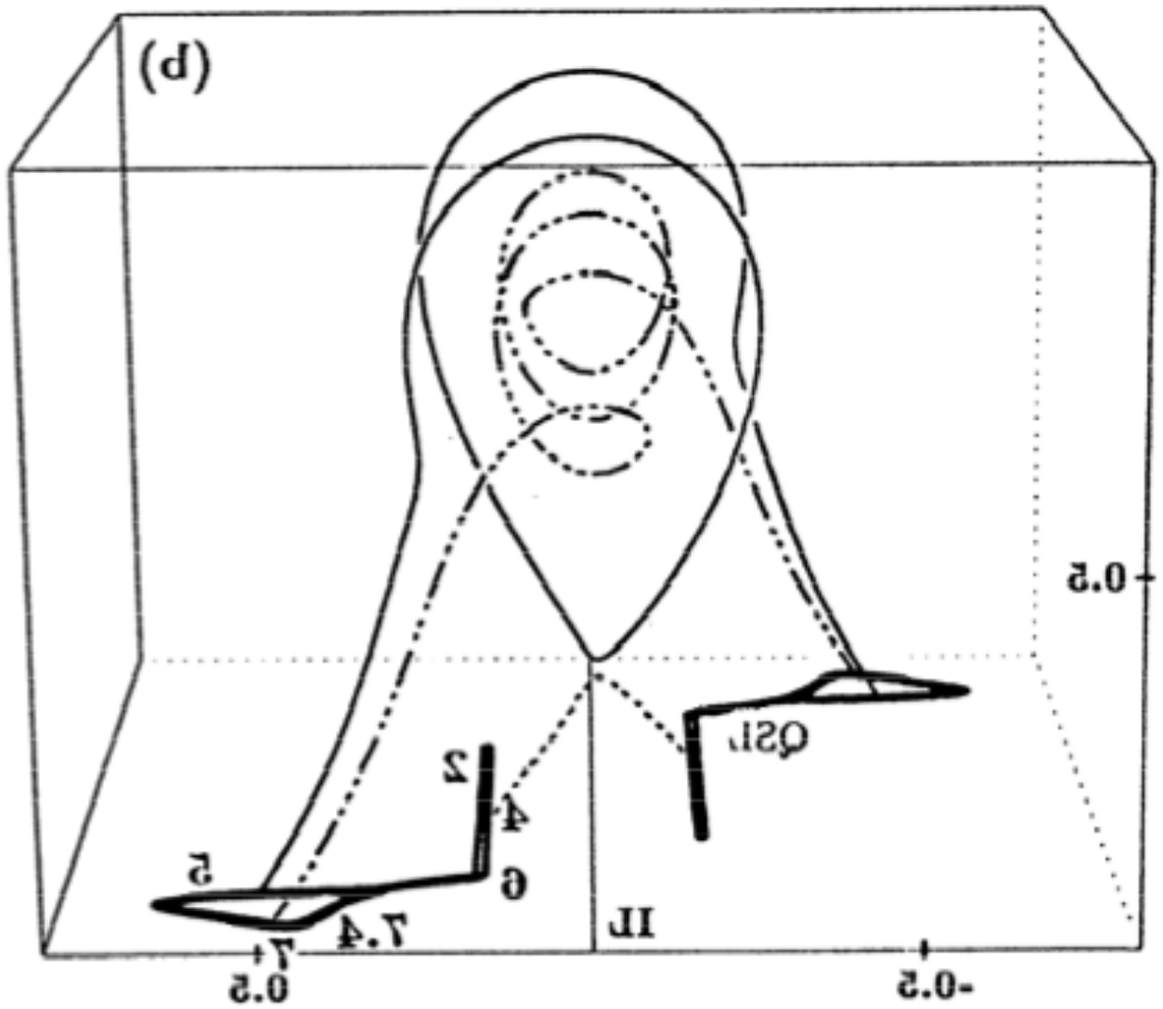

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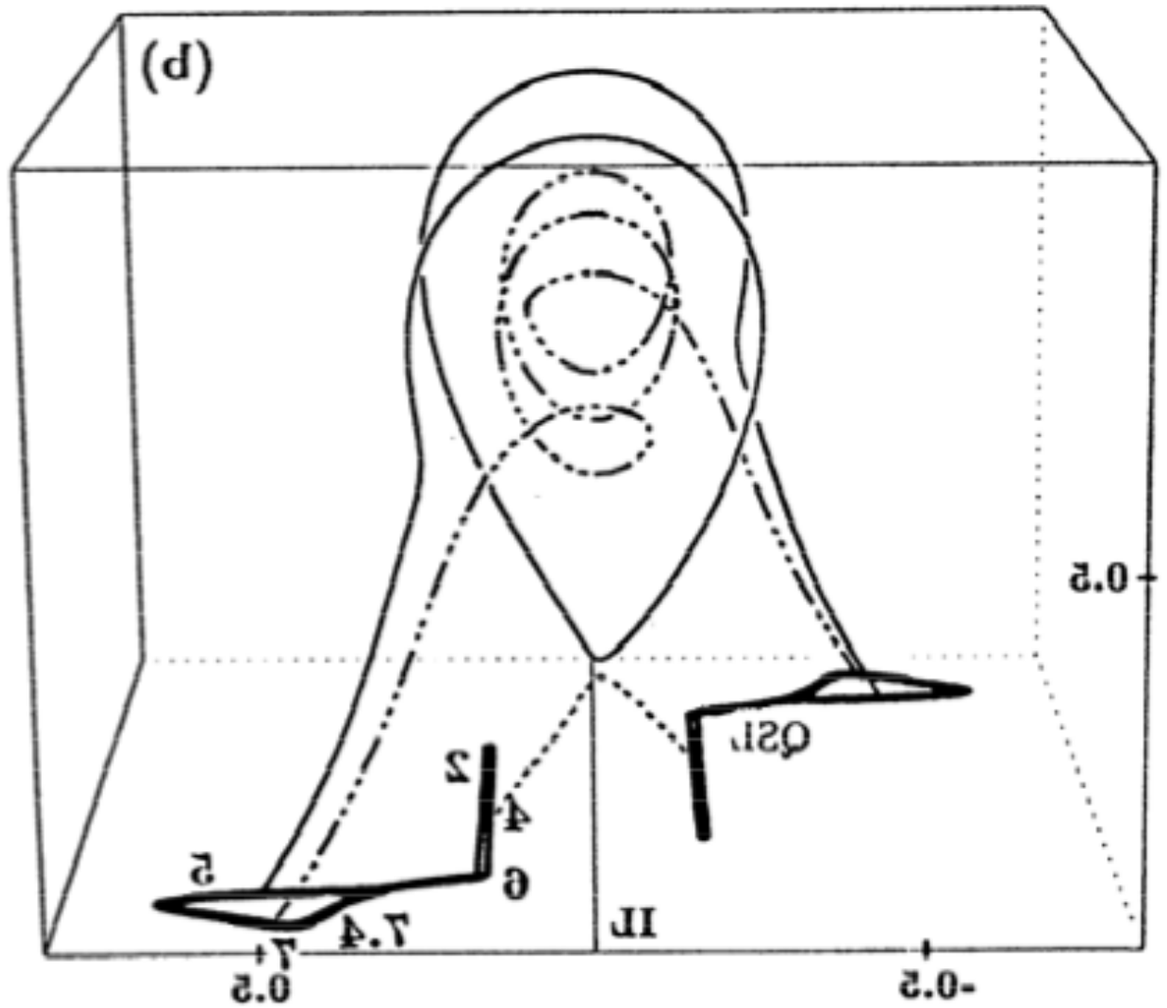

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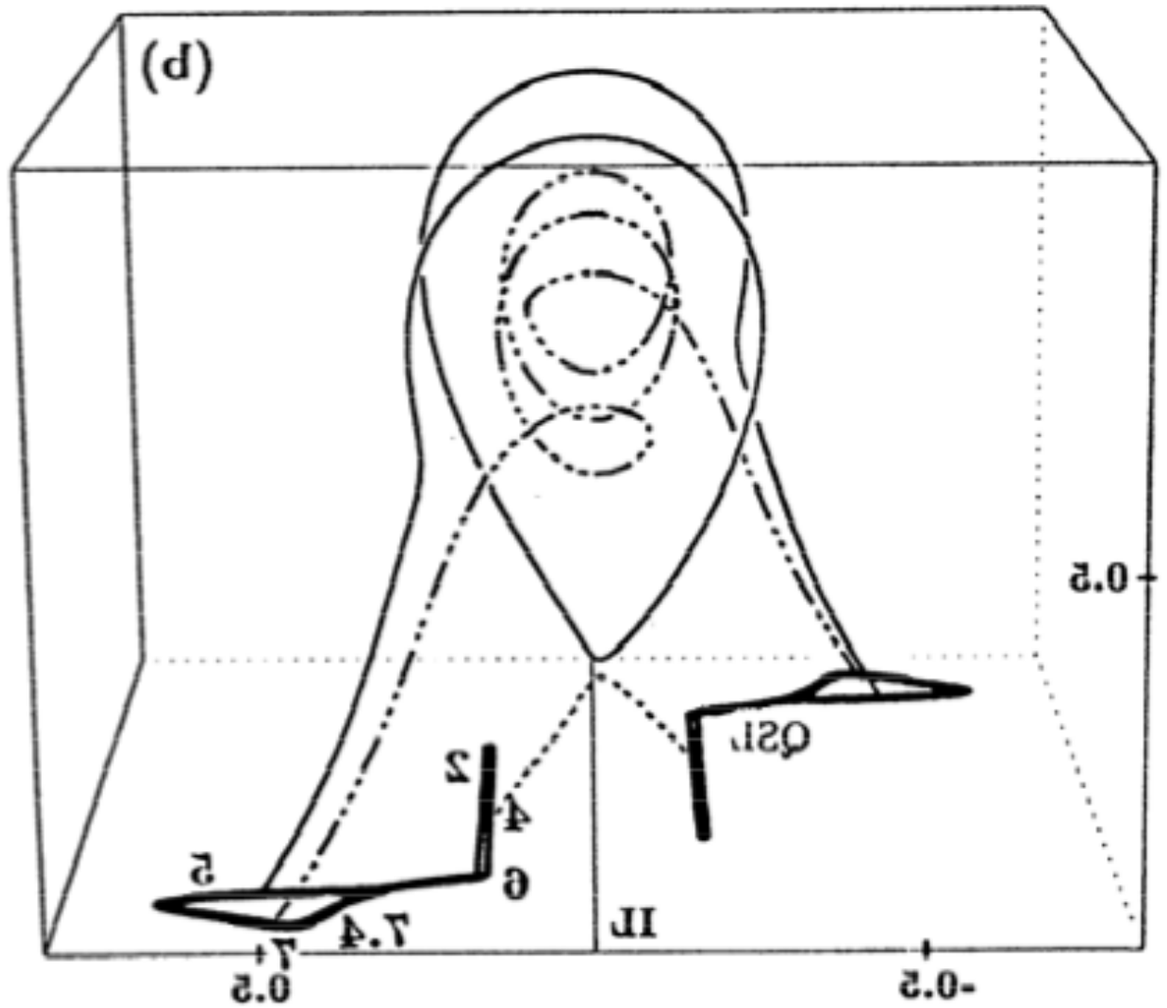

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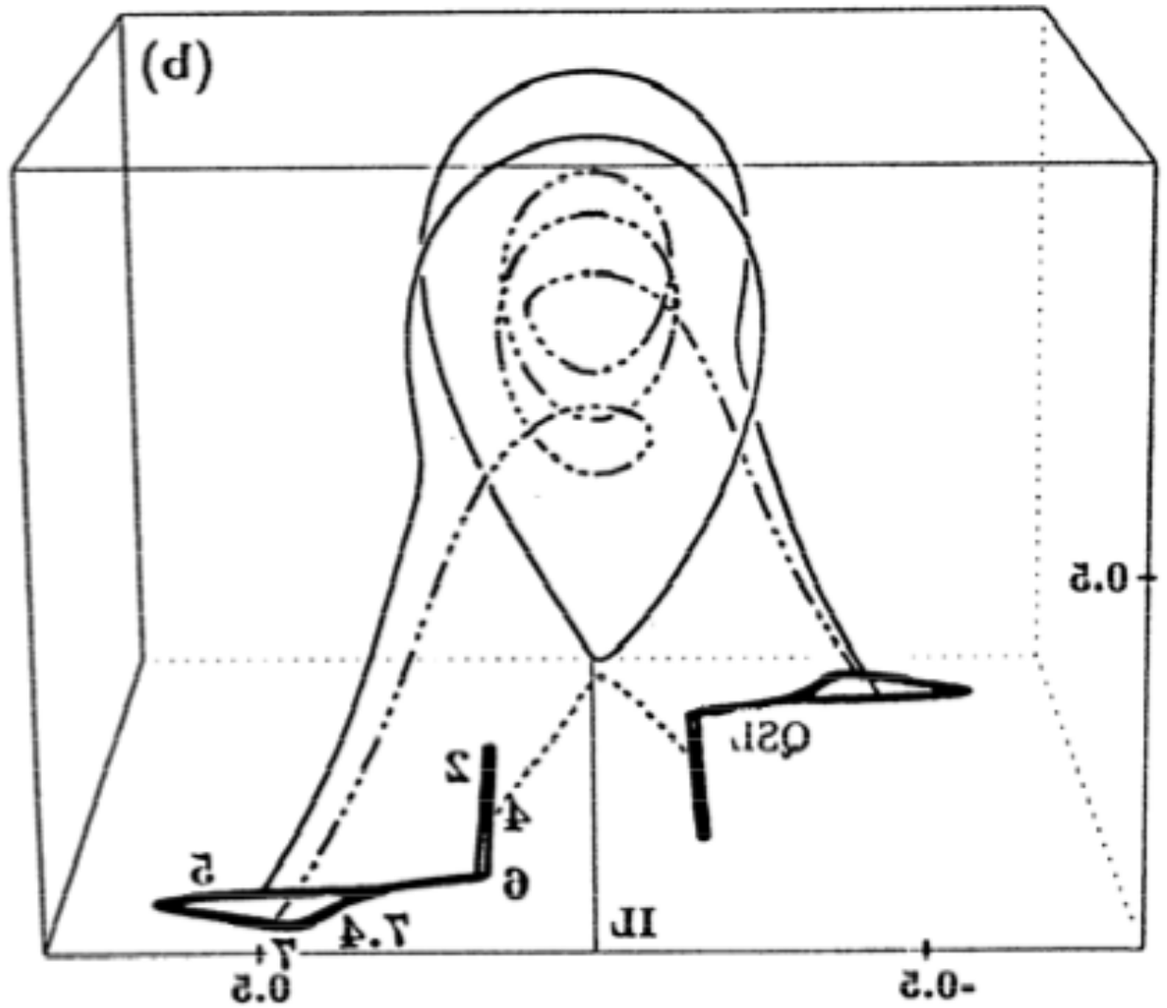

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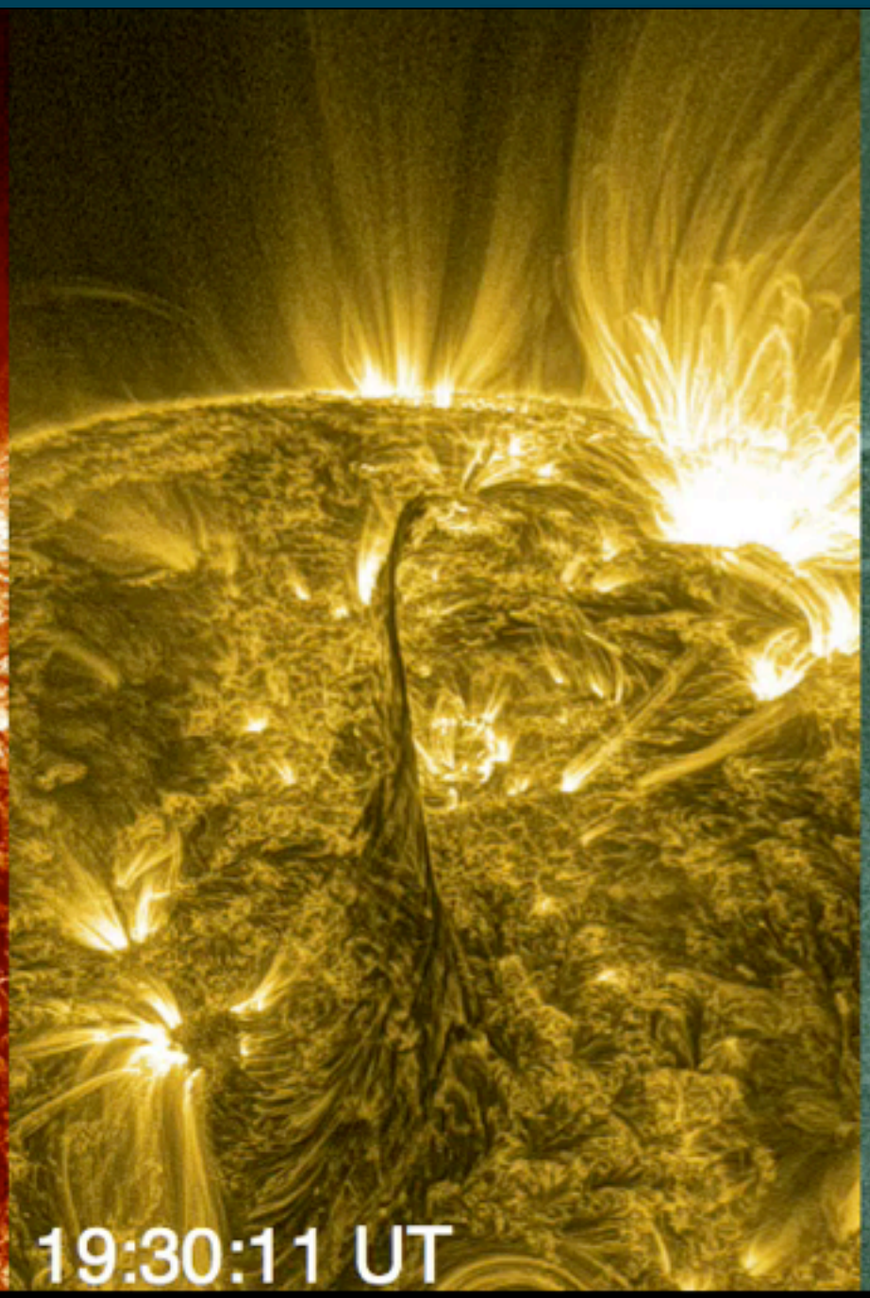
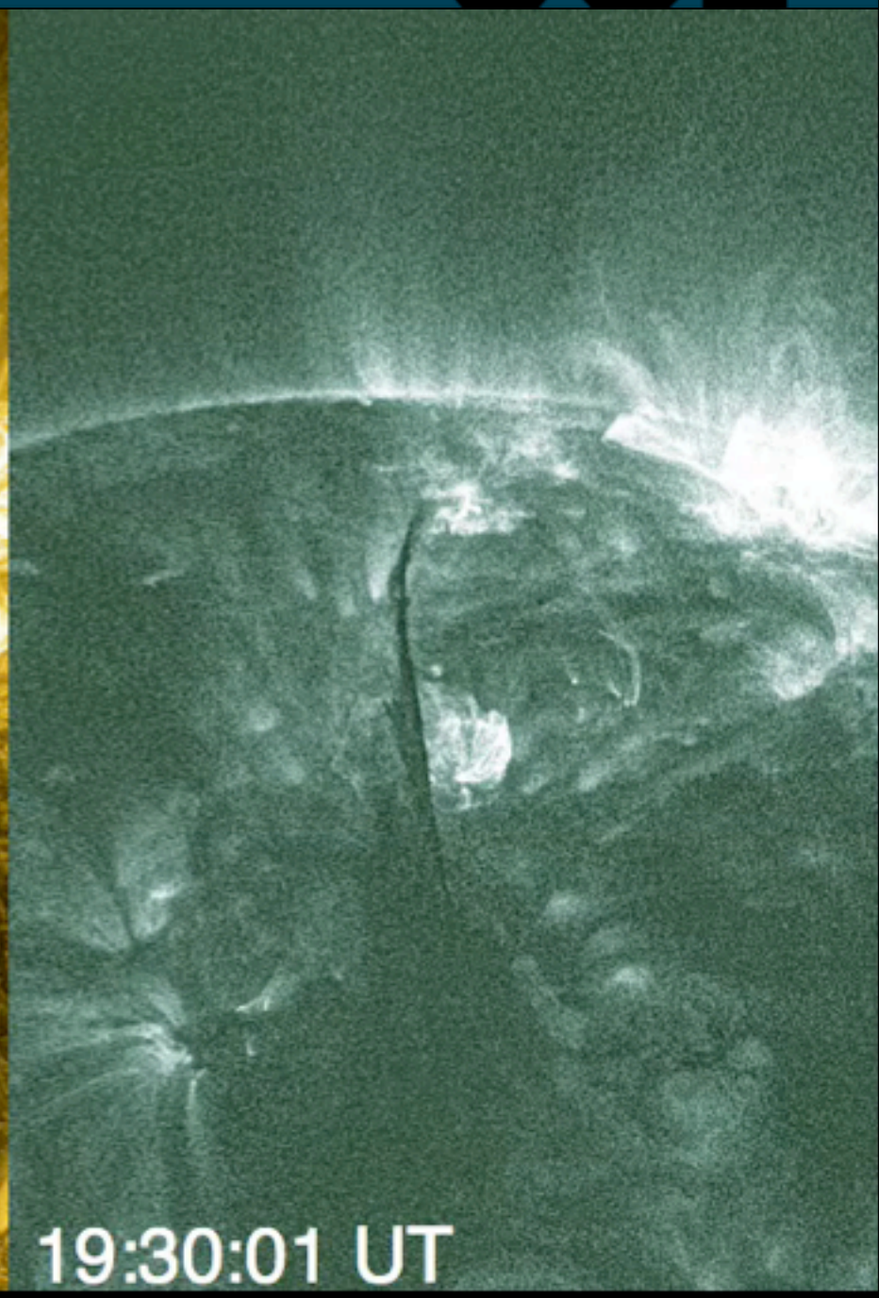
- Prime topological feature where reconnection can happen
- Anchoring of bright thread in/ surrounded by flare ribbons is hint that thread may be driven by *reconnection*

UCL





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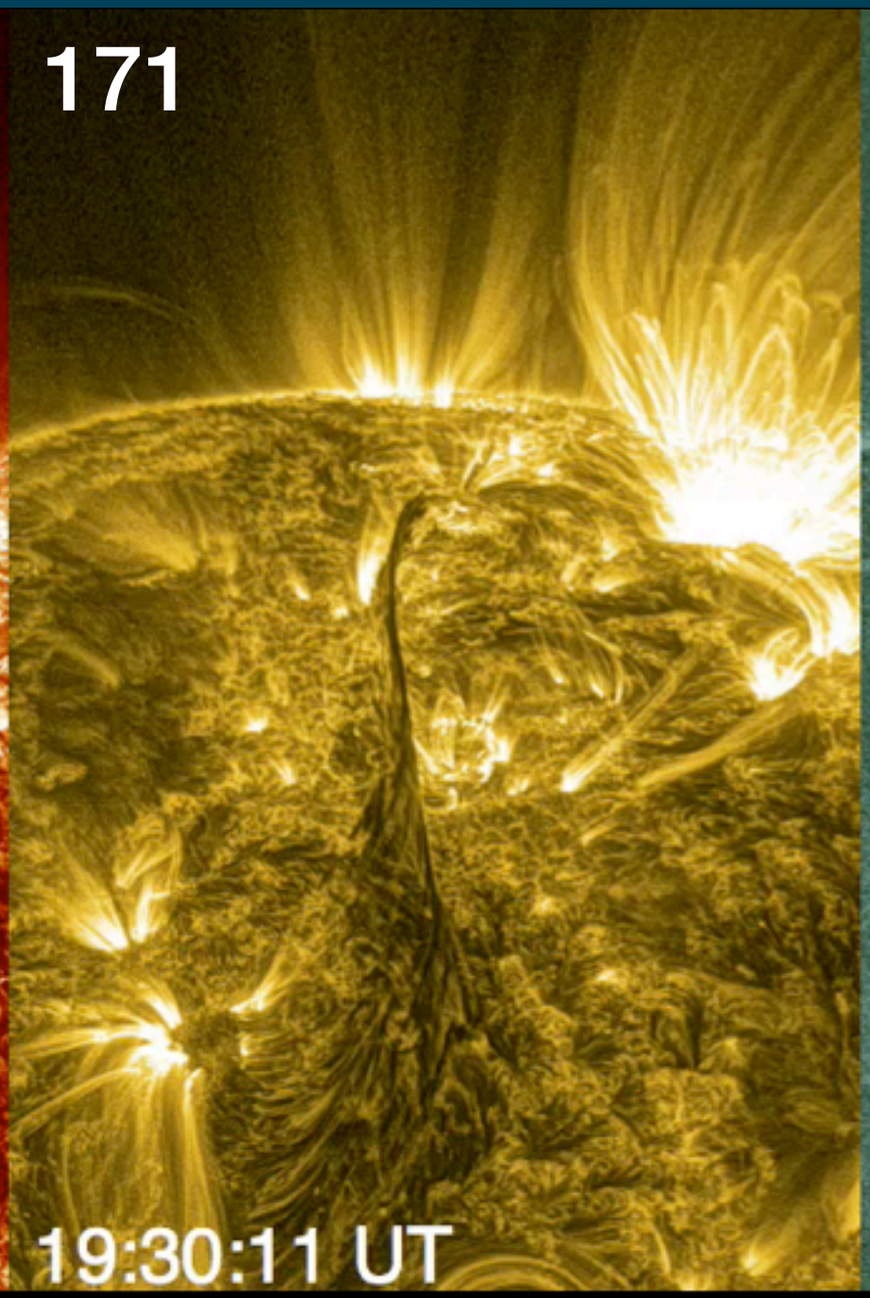

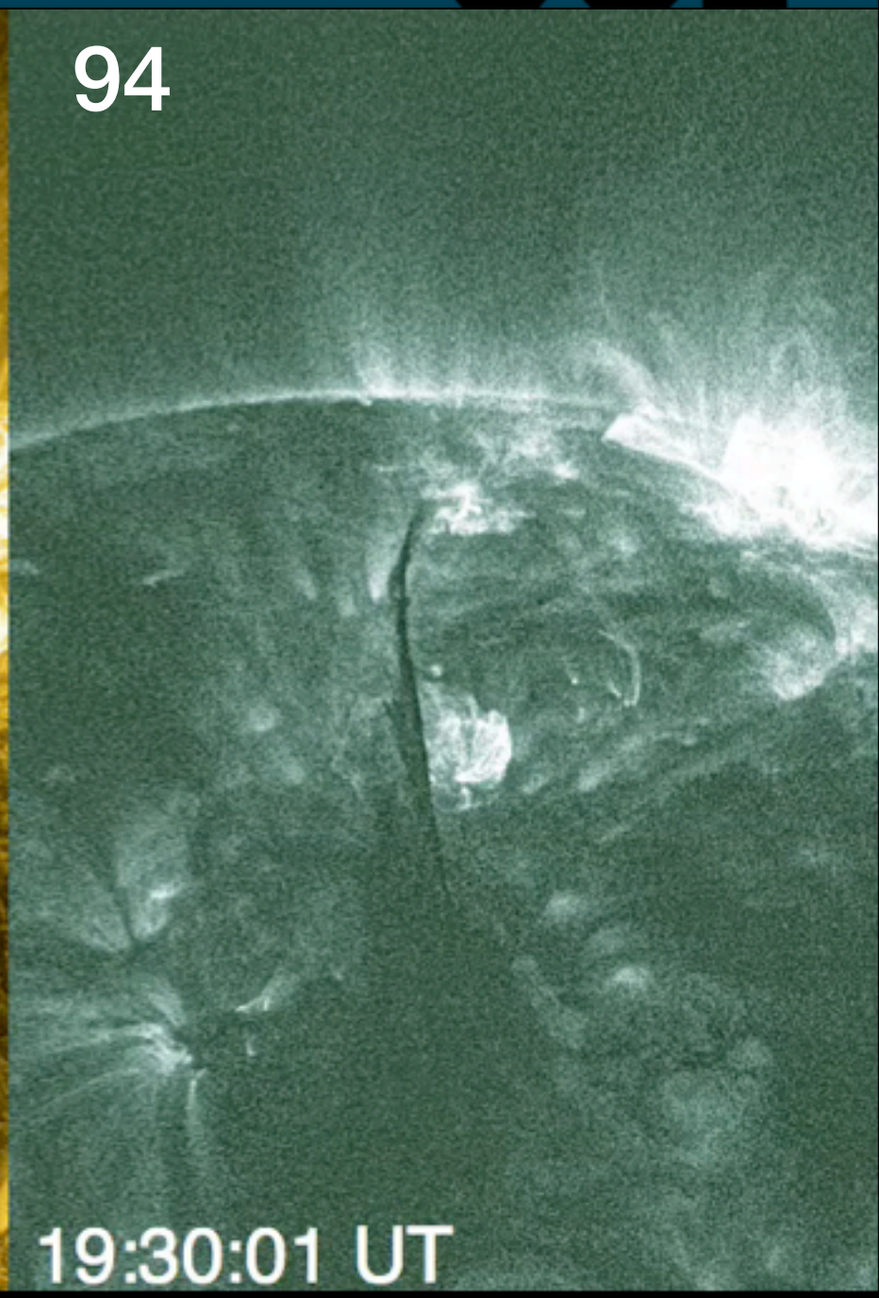

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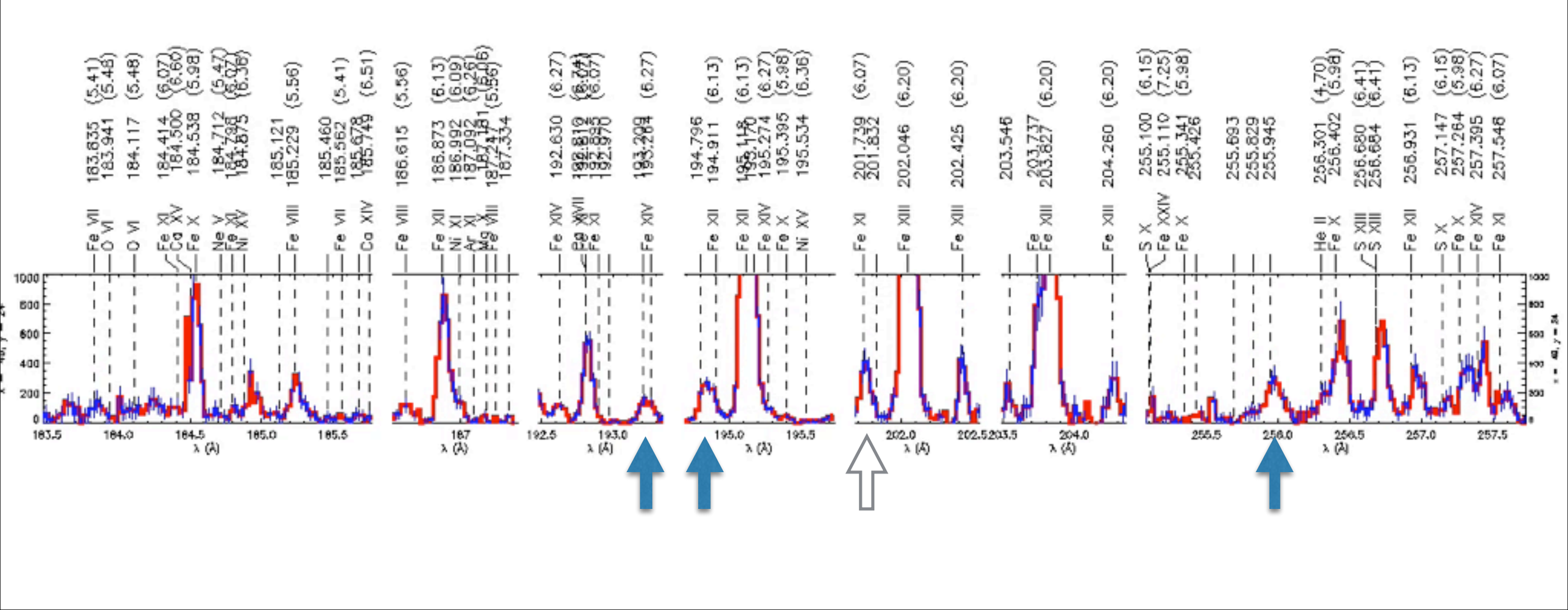
- Does it heat up?

  - Doppler shifts indicate flows are supersonic unless $T \geq 8$ MK.

But seen in “warm” lines only

Doppler motions in warm (T ≤ 2 MK) lines, but no hotter.



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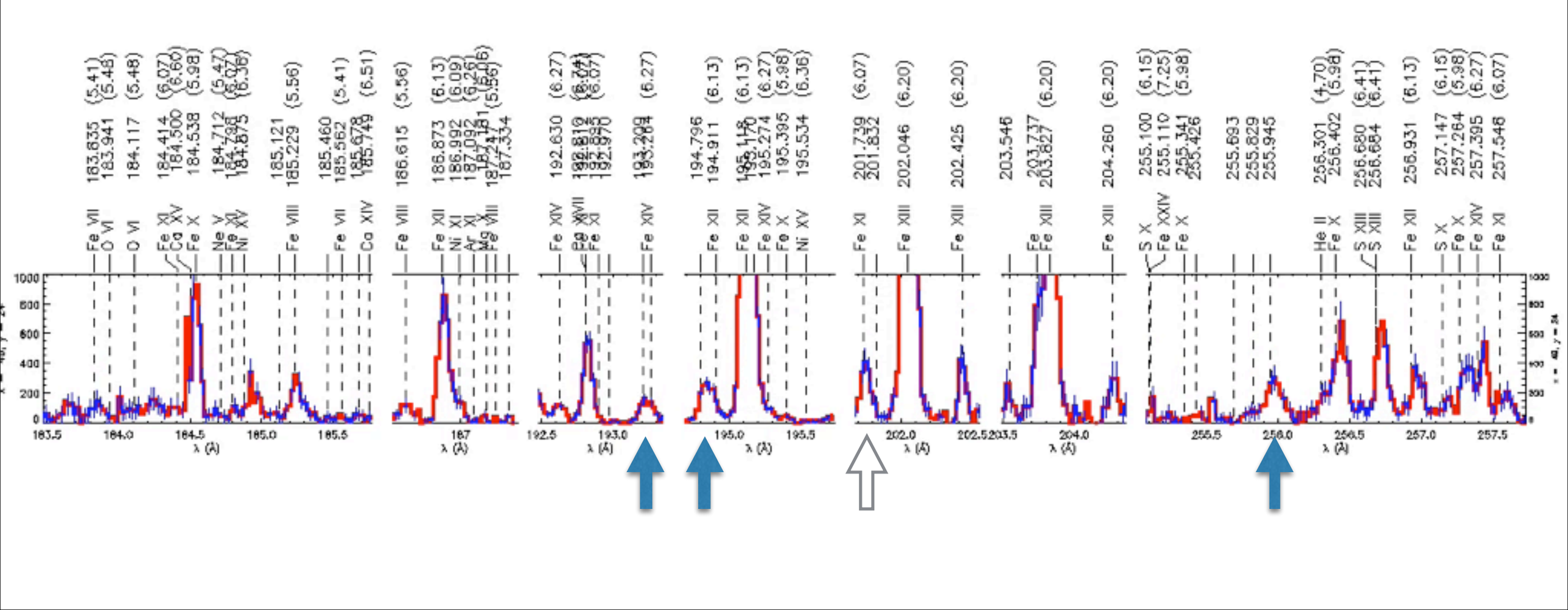

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- Accelerated material only reaches warm (2 MK) temperatures
- **Structure is rooted in/near flare ribbons**
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- Plasma may be accelerated by local reconnection
- The explanation for these up-flows has to fit into our picture of filament eruptions