Solar Explosions Imager (SEIM): A Next-Generationand High-Cadence EUV Telescope for Unraveling Eruptive Solar Features

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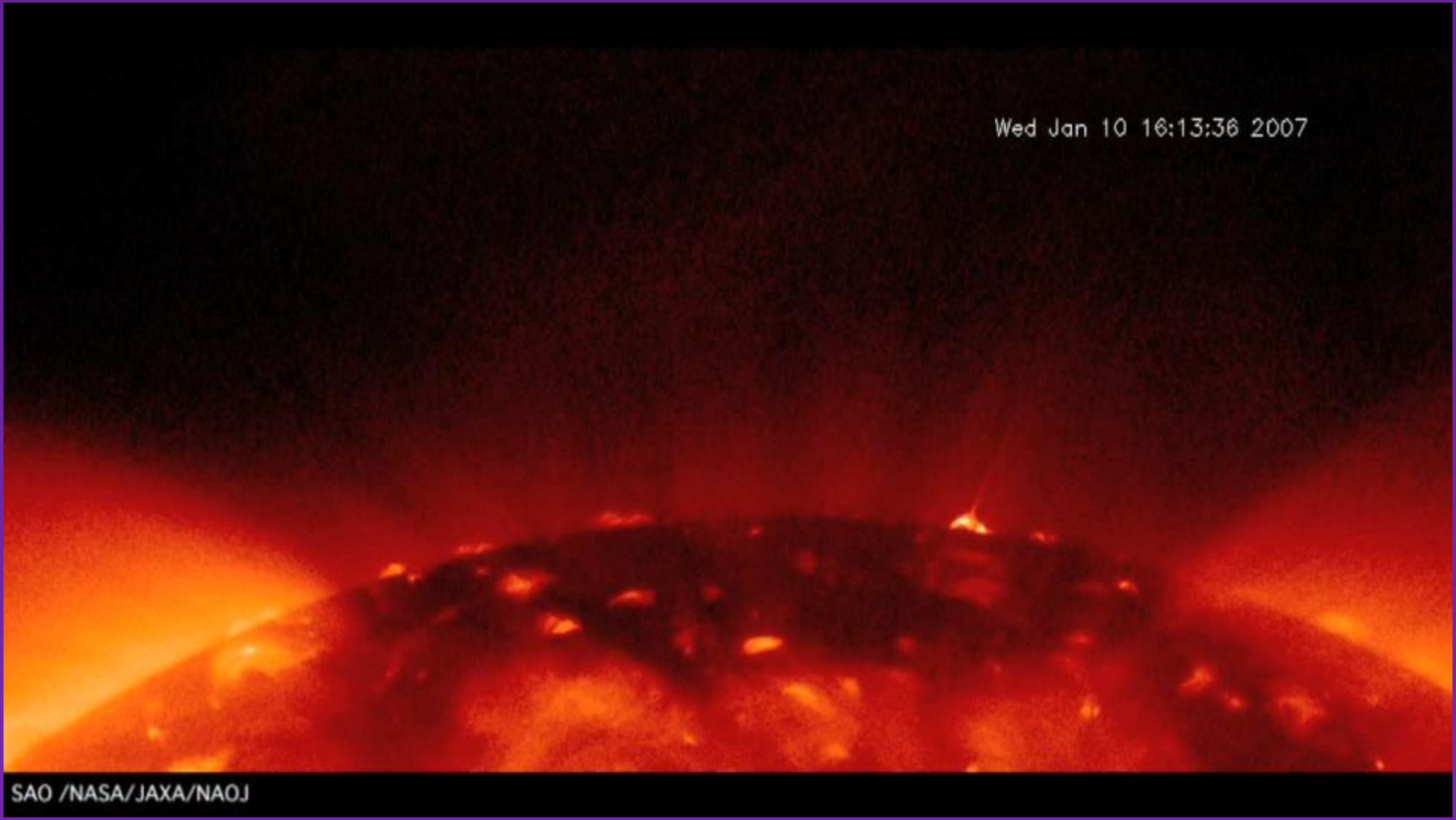


Cirtain et al. (2007)

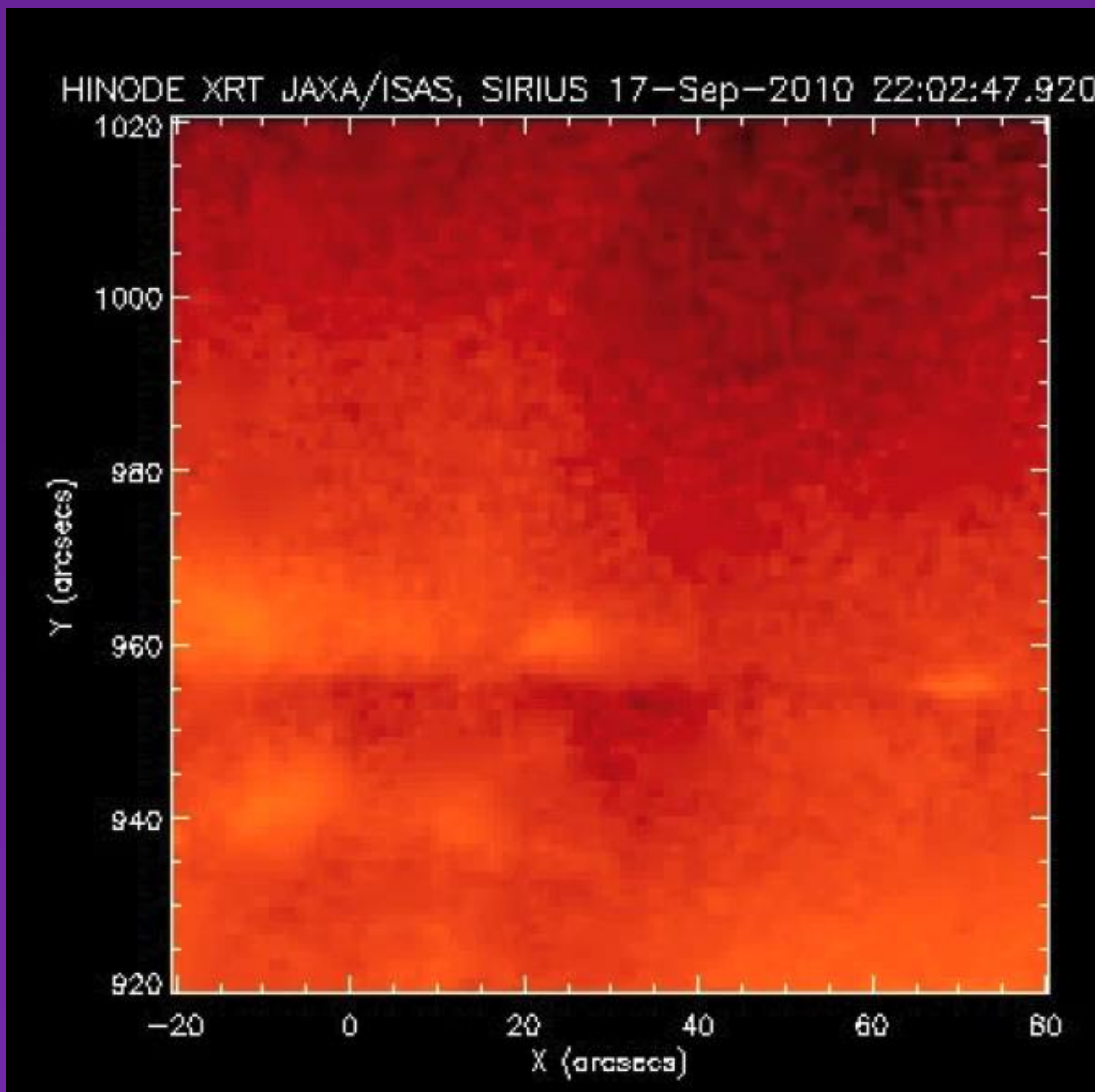
Sterling et al. (2017)

Jet Properties

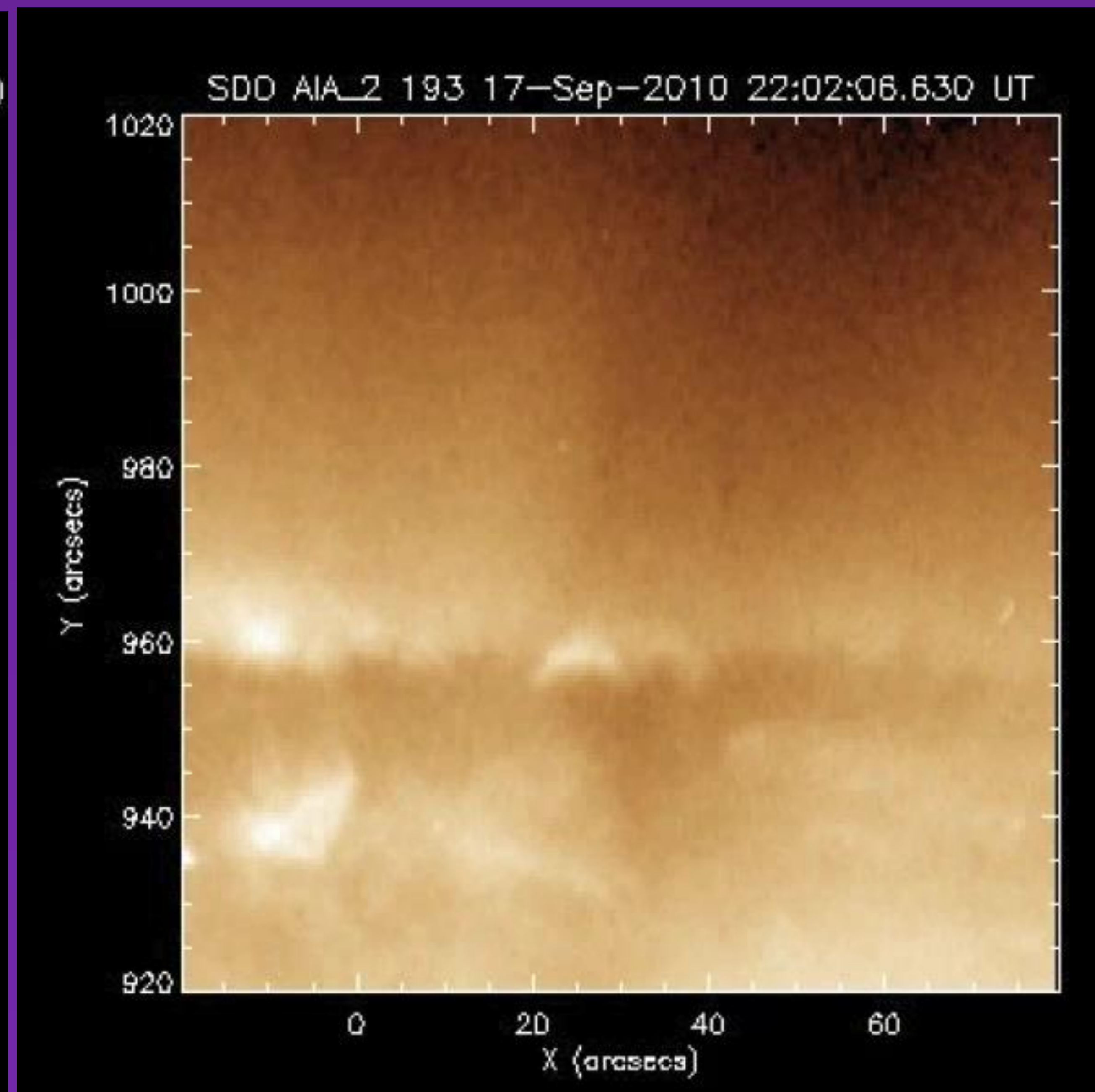
- In polar coronal holes: size ~50,000 km x 8000 km; rate ~60/day (Savcheva et al. 2007).
- Often have a "hot loop" at the jet's base.

Coronal Hole Jets: “Minifilament eruptions”

XRT



AIA 193



Sterling et al. (Nature, 2015): 20 Polar CH jets.

“Normal” Filament Eruption (TRACE)

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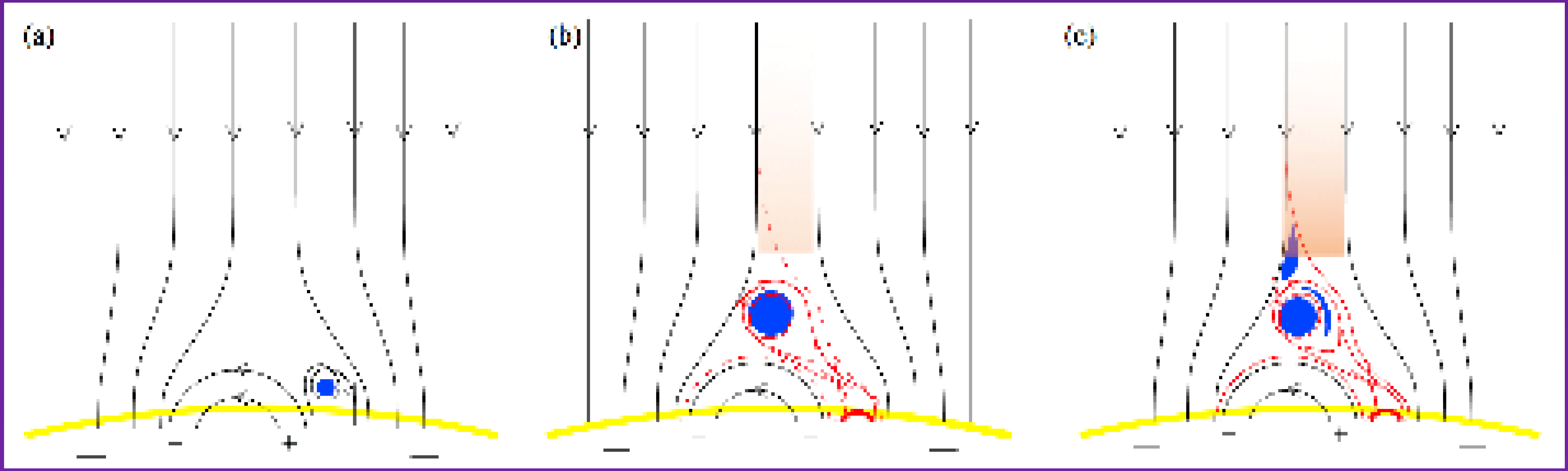
Minifilament-Eruption Model for (X-Ray) Jets



Sterling et al. (2015, 2016, 2017)

Various timings for brightenings (Moore et al. 2018)

Quite Sun jets work the same way (Panesar et al. 2016b)

Recently modeled by Wyper, Antiochos, & Devore (Nature, 2017)

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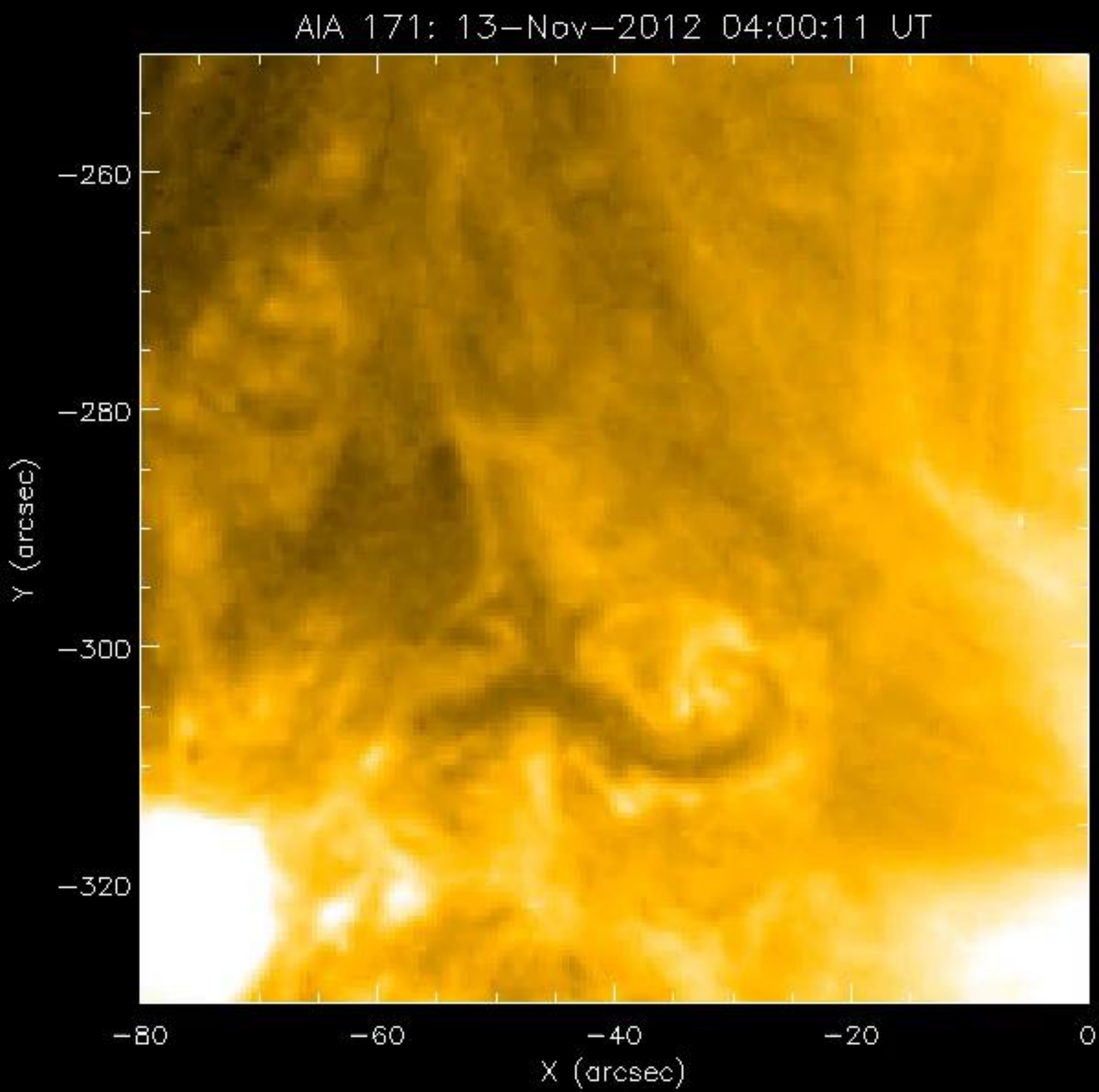
What Causes Miniature-Filament Eruptions?

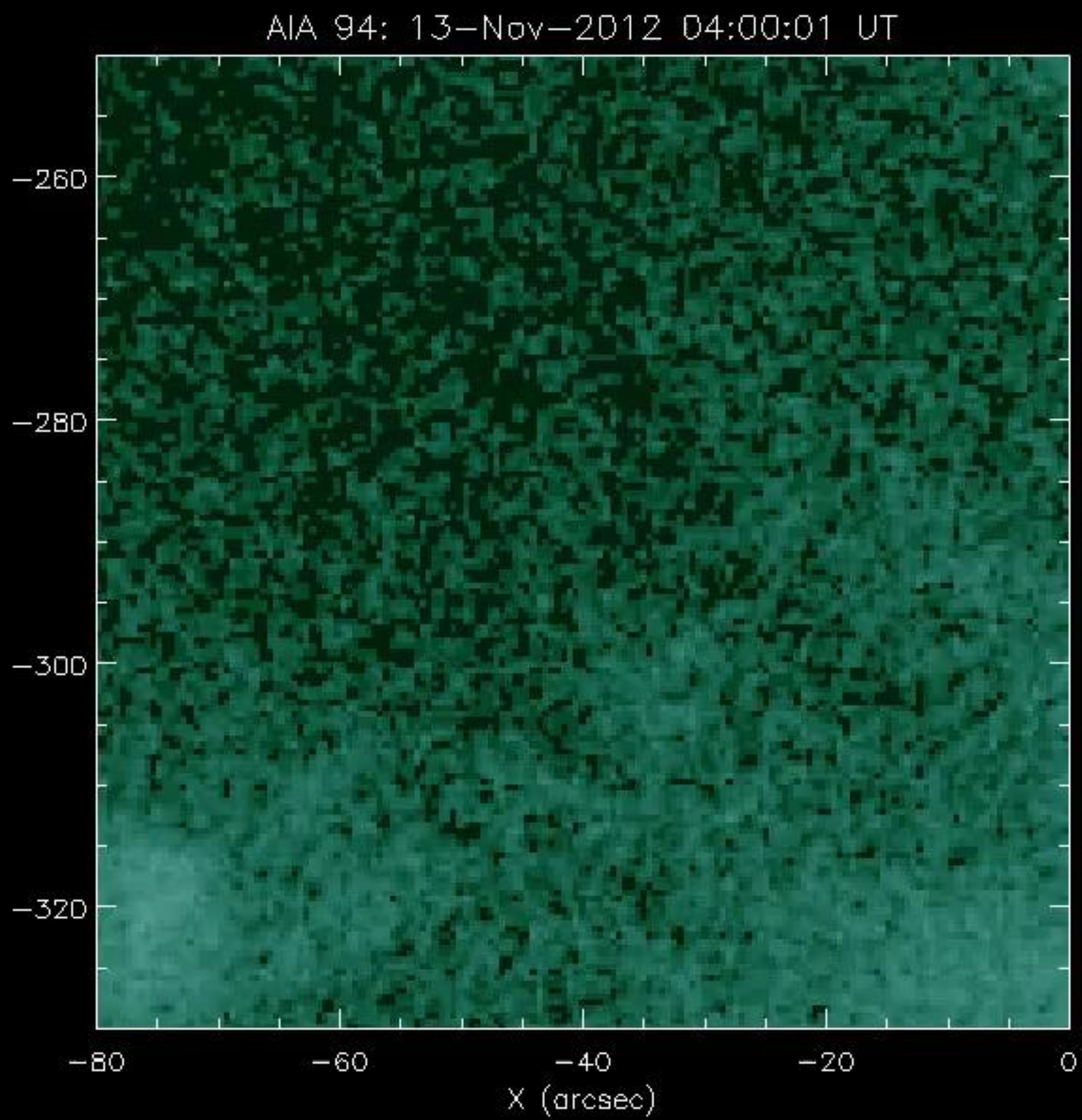
- Adams et al. (2014) found no emerging flux in the jet region. Filament erupted from location where flux canceled.
- Huang et al. (2012) and Young & Muglach (2014a,b) found jet from location where flux canceled.
- Some others, e.g., Liu et al. (2011), Shen et al. (2012), and Hong et al. (2012) found jets from location of emerging flux+flux cancelation.

Quiet Sun Jets — Similar to PCH jets

AIA 171

AIA 94

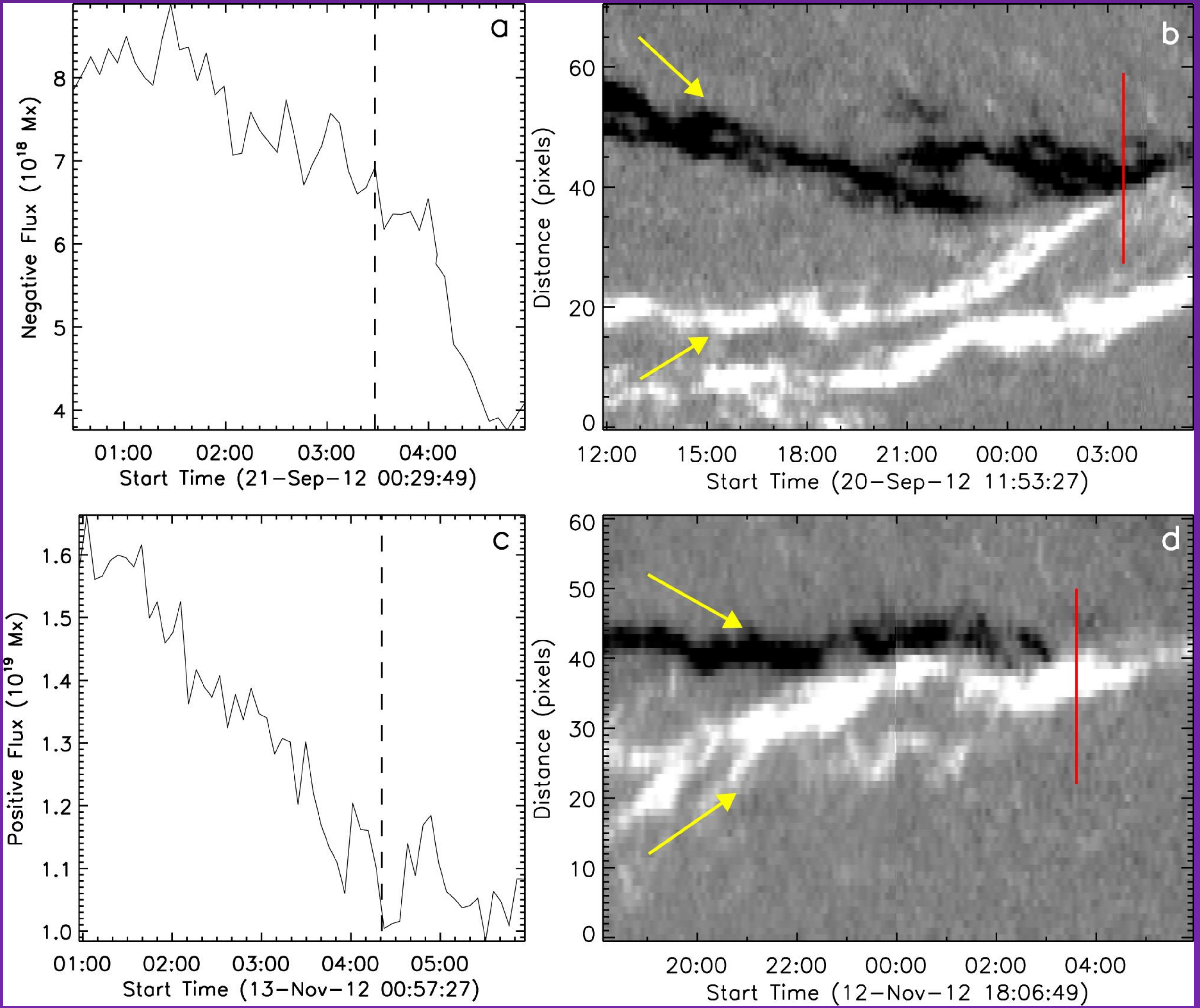




(Panesar et al. 2016b)

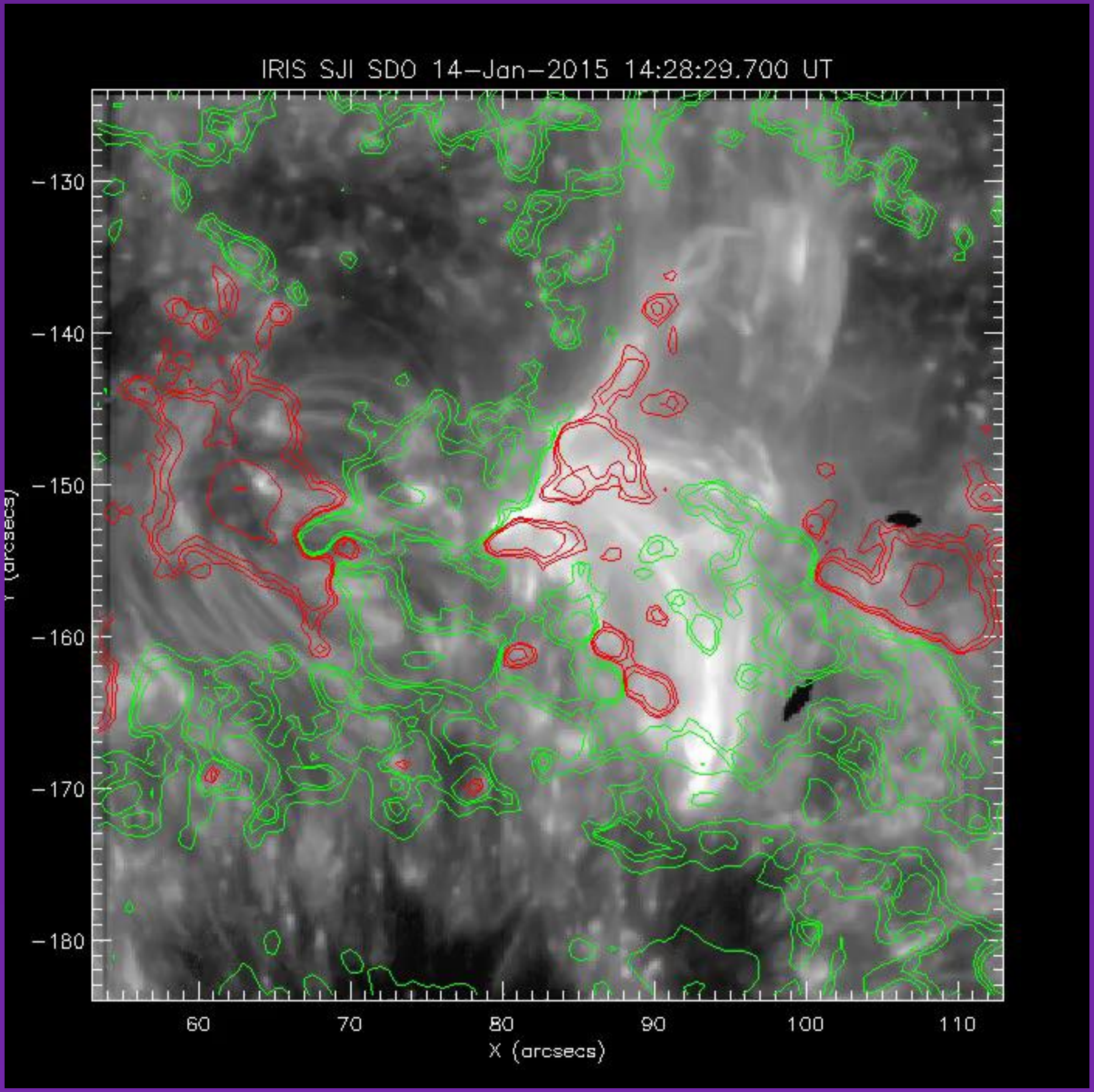
Same for QS jets: Occur at cancelation sites.

Ave. Cancelation rate: ~10^{18} Mx/hr.



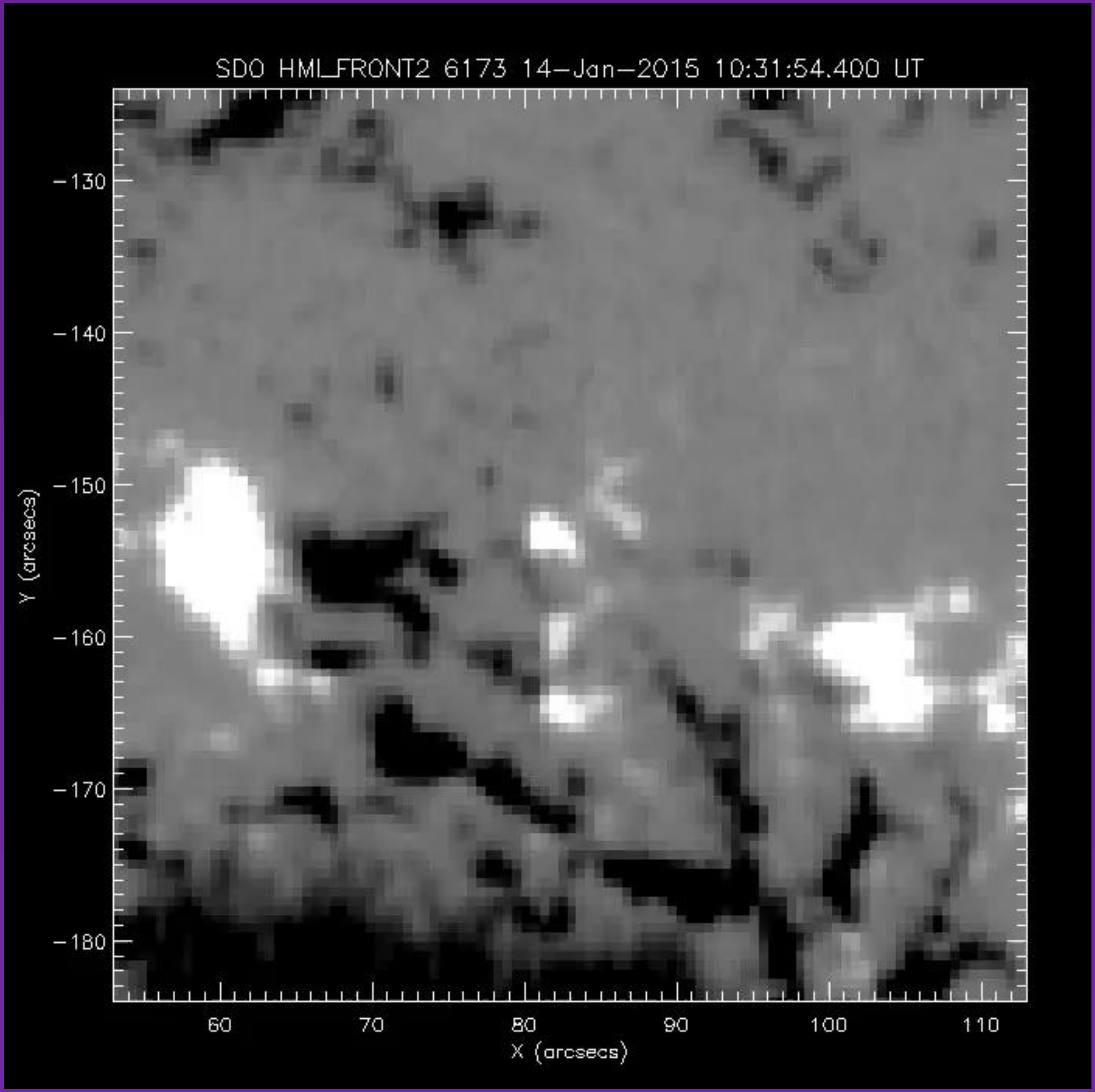
Panesar, Sterling, & Moore (2016b) — 10 jets.

Coronal Jets in Active Regions



Sterling et al. (2017)

HMI of jetting region



Jets frequently occur at *flux cancelation* locations.

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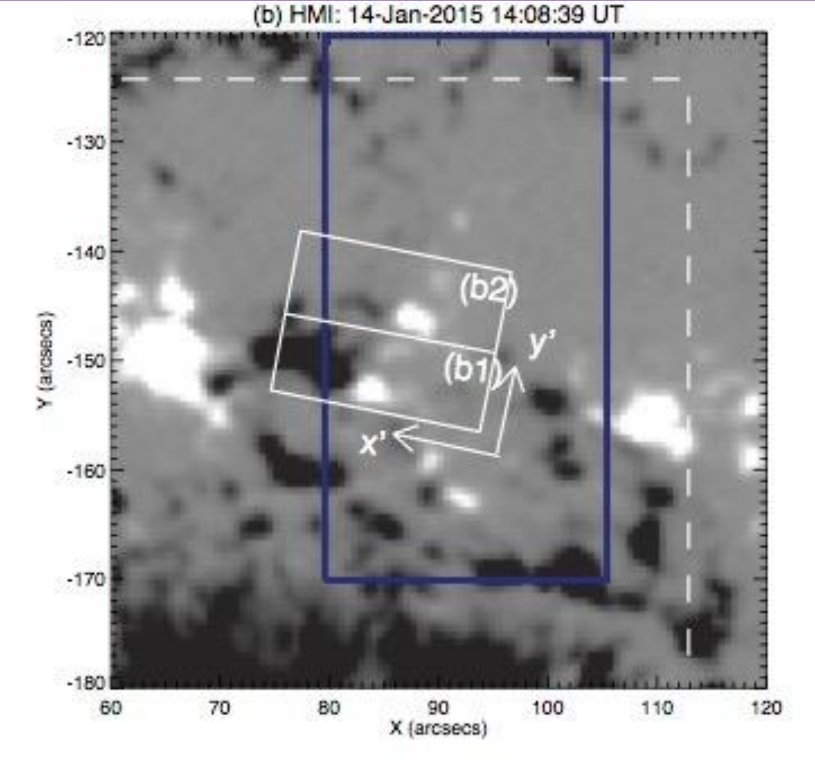
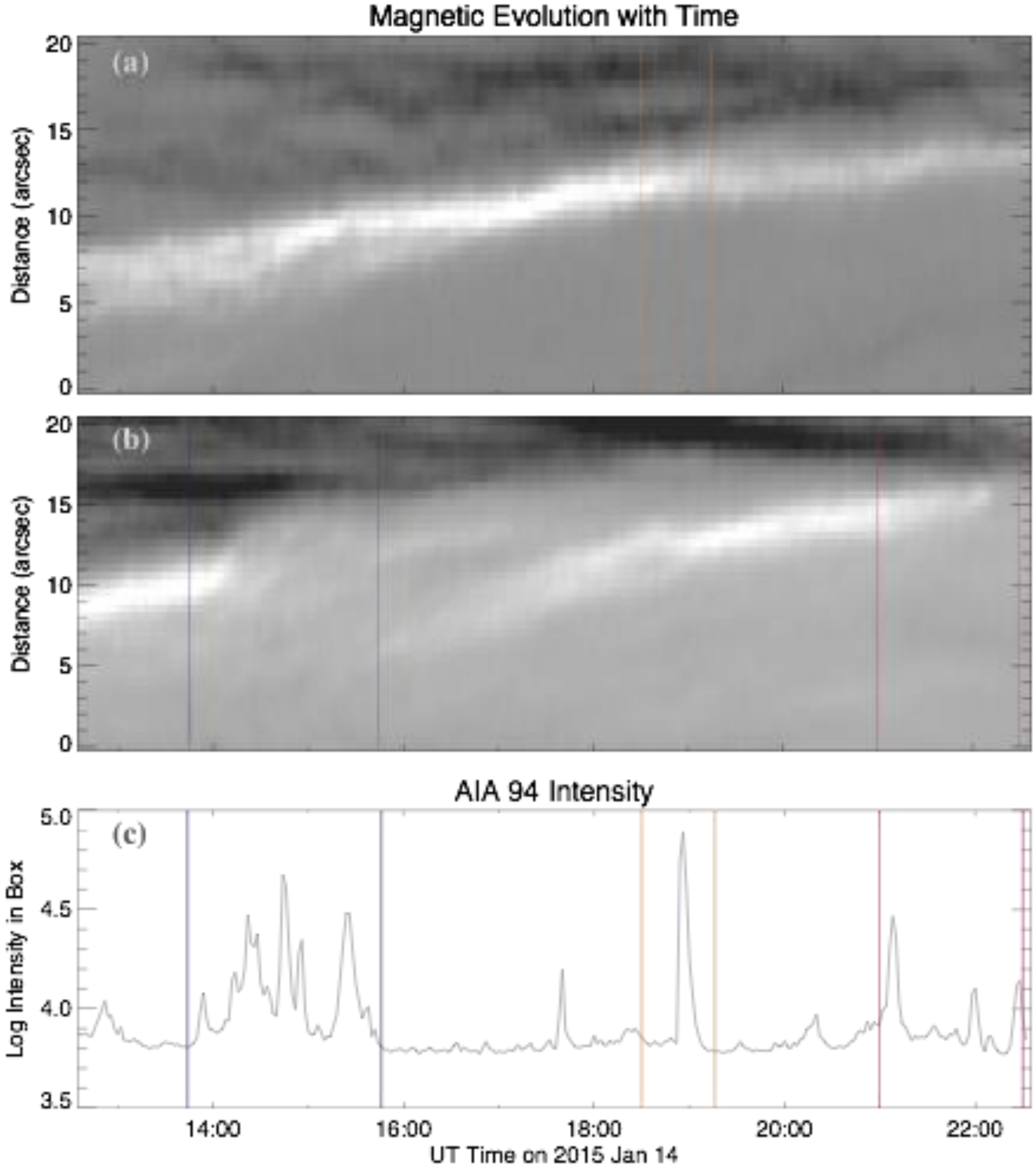
AR jets (Sterling et al. 2017)





What Causes Miniature-Filament Eruptions?

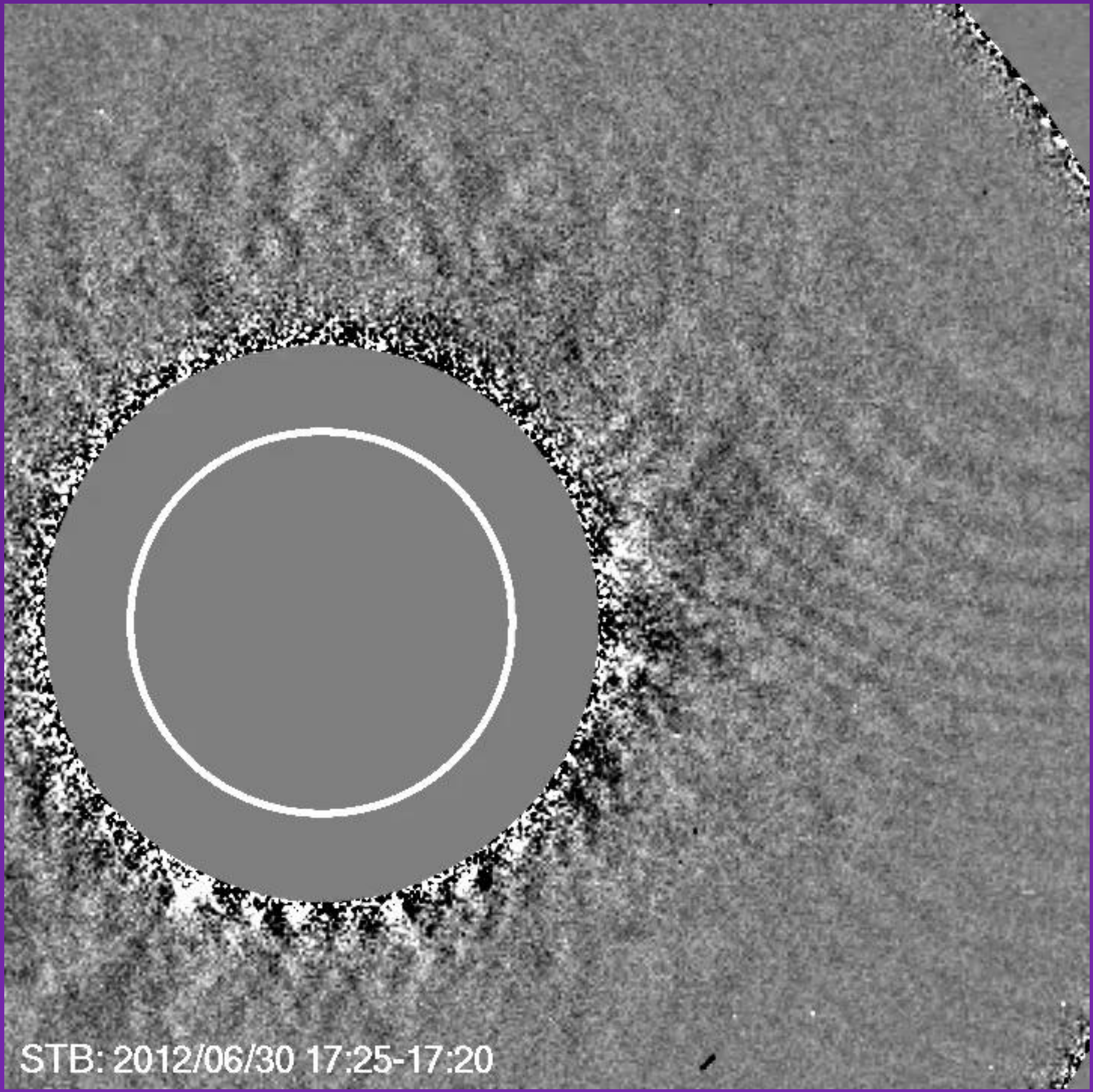
- Did not look on-disk in this study, due to polar view. But….

- Adams et al. (2014) found no emerging flux in the jet region. Filament erupted from location where flux canceled.
- Huang et al. (2012) and Young & Muglach (2014a,b) found jet from location where flux canceled.
- Some others, e.g., Liu et al. (2011), Shen et al. (2012), and Hong et al. (2012) found jets from location of emerging flux+flux cancelation.

- There may be some exceptions (Mulay et al. 2016, Kumar et al. 2018). Must study more, and in greater detail.

Jets and CMEs: History (sampling)

- Wang et al. (1998) - EIT and LASCO white-light (WL) jets.
- Nisticò et al. (2009) - STEREO; 5/79 “micro-CMEs”/jets.
- Moore et al. (2015) - Narrow jets from higher-twist jets.
- Sterling et al. (2016) - Narrow WL jets from AR jets.
- Panesar et al. (2016) - Broader CMEs from AR jets.
- Several single-event studies:
  - Hong et al. (2011) - Micro-CME originating from a blowout jet triggered by flux cancelation.
  - Shen et al. (2012) - Bubble-like CME from a blowout jet (SDO, STEREO, Hα).
- See Raouafi et al. (2016) review for more.



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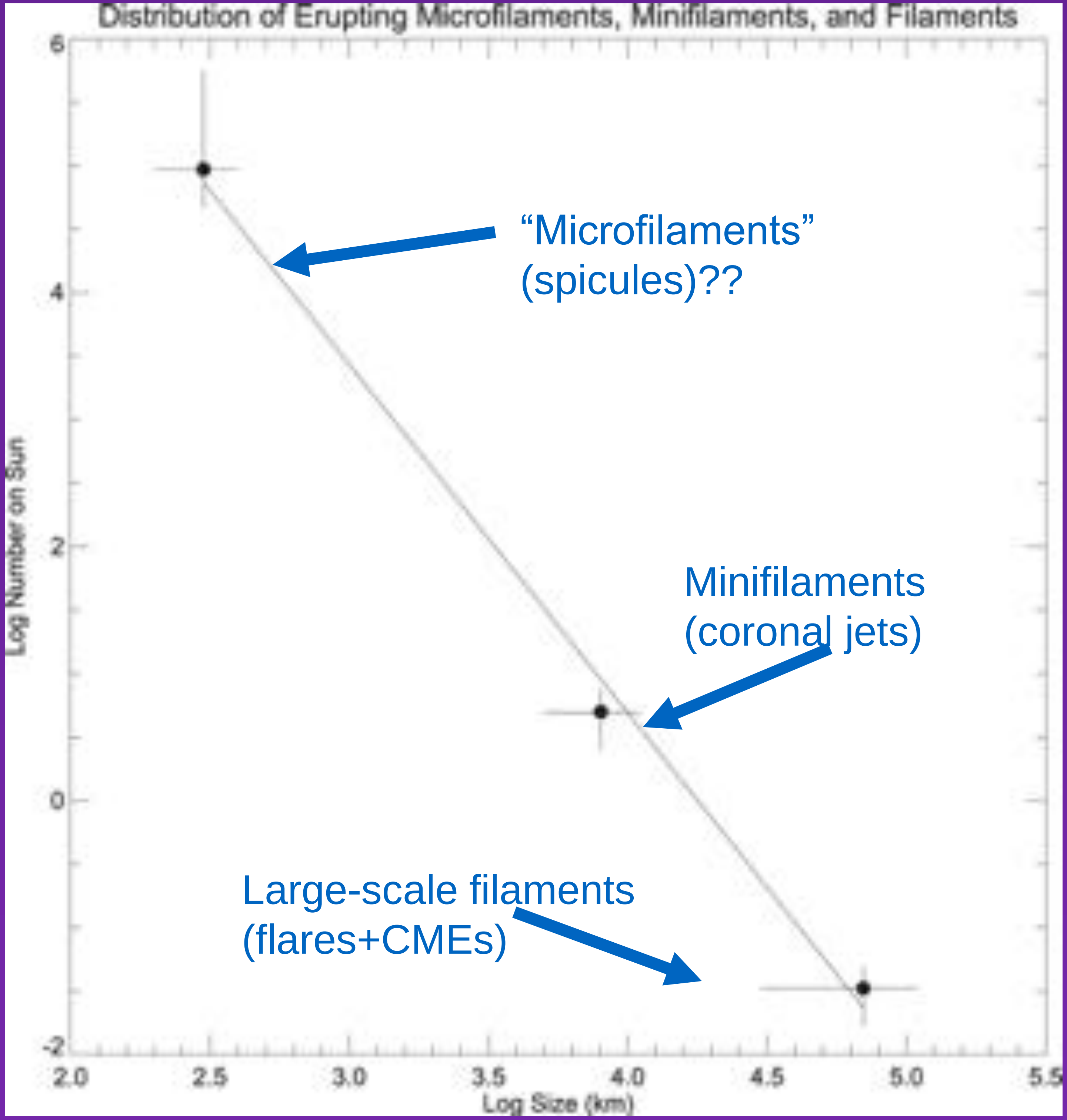
Filament-Like Feature Eruptions on Smaller Scales??

Log Number of Eruptions



Log “Filament” Size

Sterling & Moore (2016)

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Questions/Issues to Address:

- Cause of jets - magnetic cancelation? Role of emergence?
- Detailed eruption processes (e.g. Wyper et al.
- Are AR jets the same as QS and CH jets? (Role of cancelation between pre-twisted emerging flux and surrounding field.)
- Role of twist in jets (e.g., Moore et al. 2015).
- Clarify connections to larger-scale eruptions (e.g., Sterling et al. 2018).
- Clarify connections to small-scale eruptions (De Pontieu et al., various; Martinez-Sykora et al. 2016; Sterling & Moore 2016).

Solar Explosions Imager (SEIM).

- Single-Optic EUV imaging.
- Multiple wavelengths.
- “High” resolution.
- “High” cadence.
- “Adequate” field of view.

Instrument Requirements

- Wavelength:
  - One of 171, 193, 211 Å — show jets well.
  - 304 Å— includes cooler atmospheric emissions.
  - 94 Å hot features, e.g. jet-base bright point.
  - 1600 Å — match to ground-based, DKIST.

Minimal package: 304, 193, 94, 1600 Å.

Instrument Requirements

- Resolution:
  - AR minifilament "strands," $\lesssim$ 2".
  - Hi-C sees much with 0".1 pixels (e.g., Kobayashi et al. 2014, Brooks et al. 2013, Tiwari et al. 2016).

Pixel size $\lesssim$ 0".1 will revolutionize jet studies!

- Cadence:
  - AIA 12s adequate for many jets, so goal is cadence ~5 s.
- Field of View:
  - Jet bases $\lesssim$ 0′.5, FOV similar to Hi-C, ~6′.

This is ~1/6-th AIA FOV, so AIA-like detector yields desired resolution (AIA has 0''.6 pixels).

Extensions

- Synergy is essential:
  - Magnetograph (more SEIM-dedicated than DKIST).
  - White-light (more SEIM-dedicated than DKIST).
  - X-ray instrument.
  - (Imaging) EUV spectrometer.

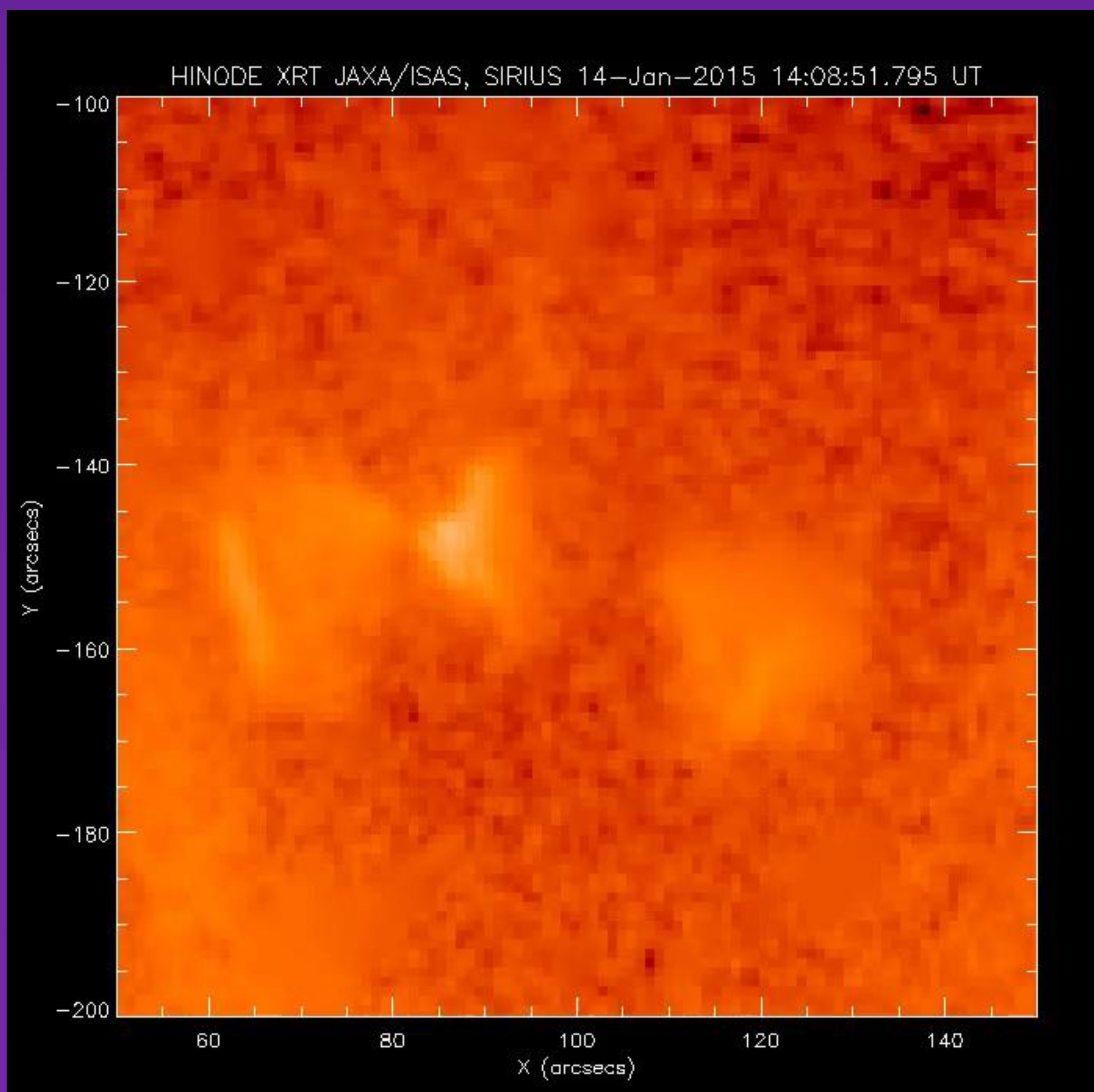
Summary

- SEIM is an EUV imaging single-optic instrument, observing in at least 304, 193, 94, and 1600 Å, with ~0''.1 pixels and 5 s cadence.
- Will see jets in all solar regions (CHs, QS, and ARs).
- Jets may be proxies for larger (CME-producing) and smaller (spicule-like) phenomena.
- Synergy with other onboard(?), separate, and ground-based instruments.
- Invaluable observations for many solar features - *Not Just a Coronal Jet Mission!*

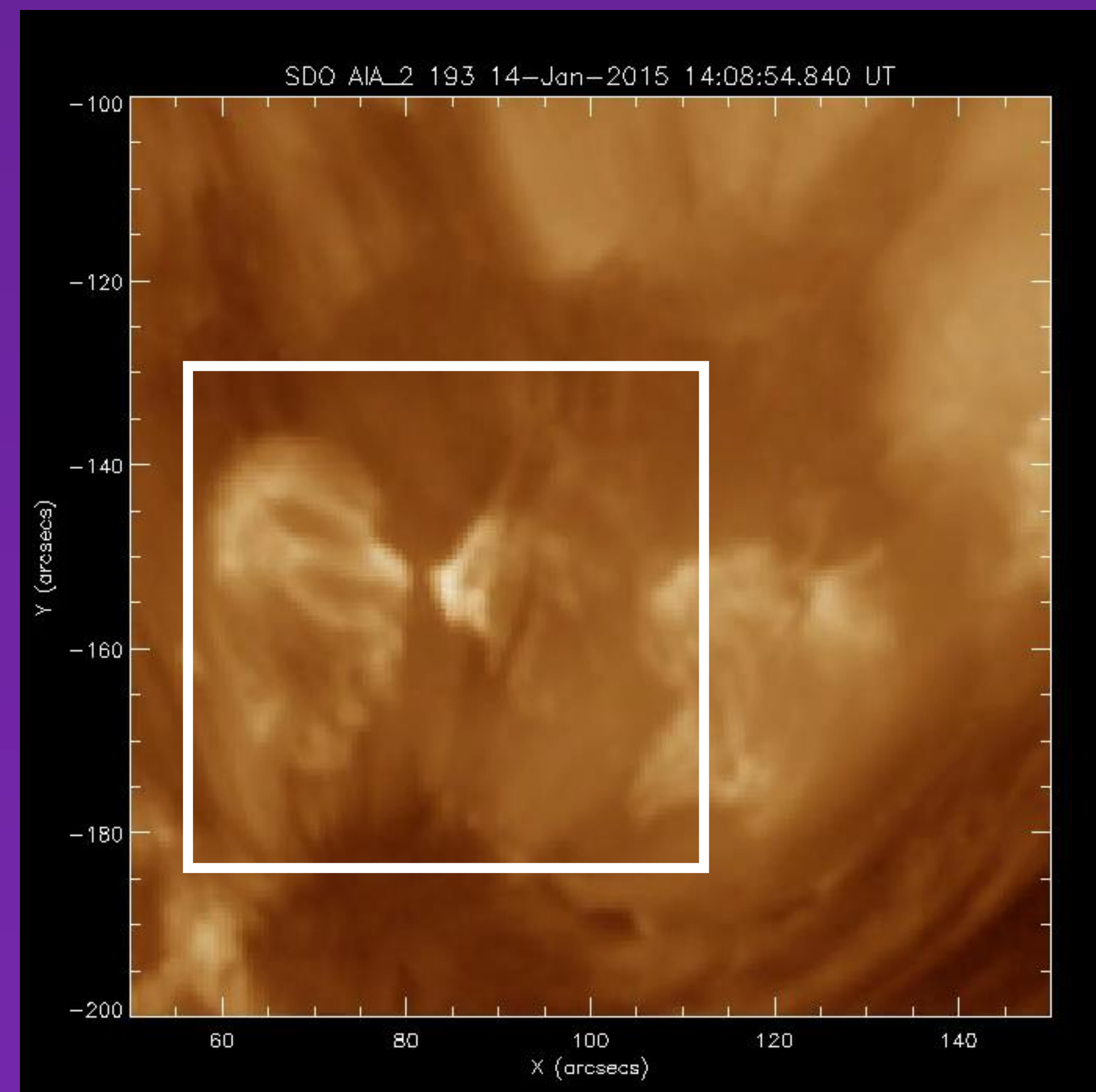
Image:
Alphonse Sterling
21 August 2017,
Lewisville, Idaho

An Example: AR Jets

- 14 Jan 2015 (NOAA AR 12259).
- AIA, HMI, Hinode, IRIS
- Sterling et al. (2017)



Hinode/XRT



AIA 193

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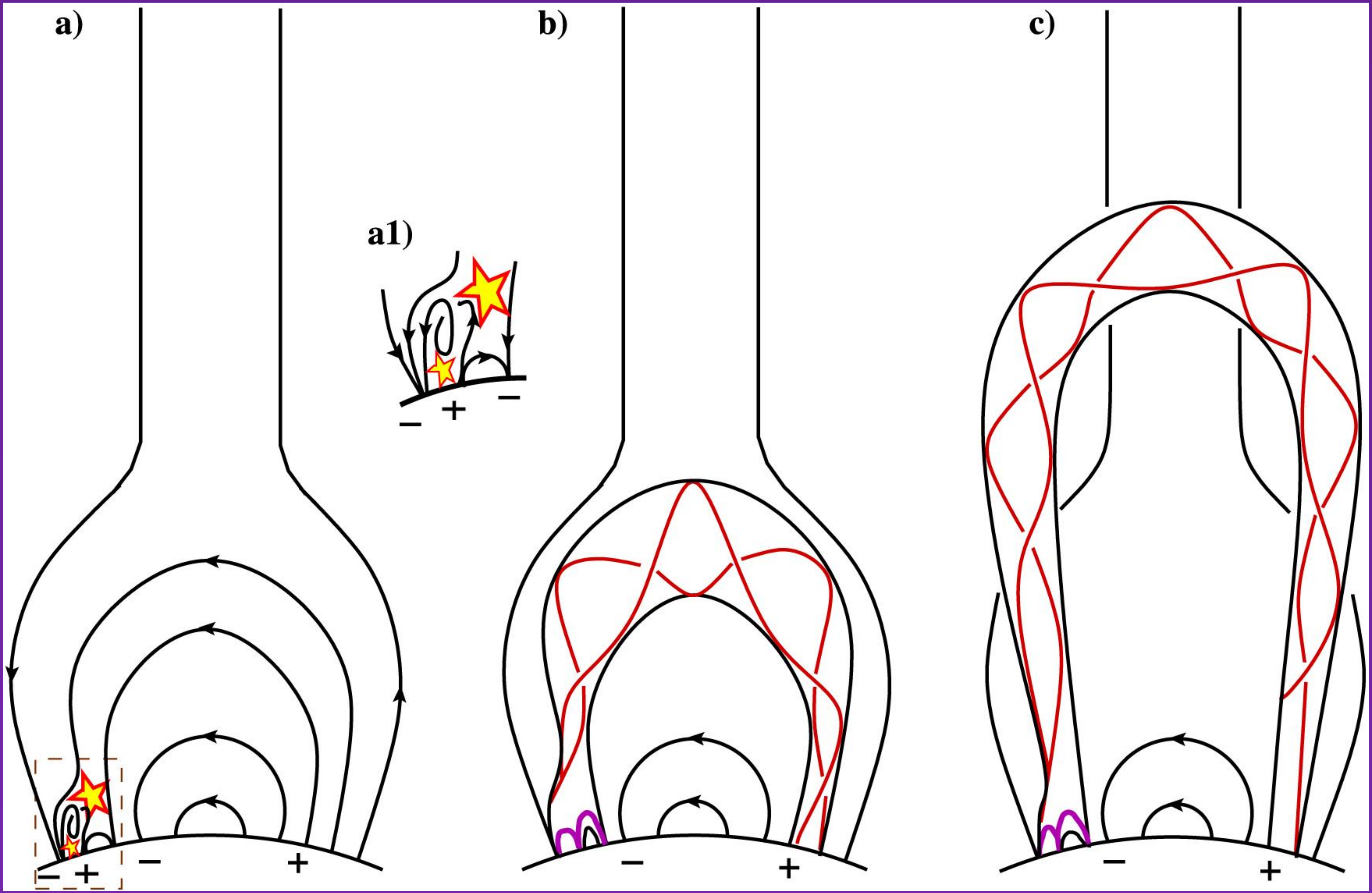

(Update to Bemporad et al. 2005 picture of “streamer puff” CMEs.)

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