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

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Certain et al. (2007)
Sterling et al. (2017)
Jet Properties

- In polar coronal holes: size $\sim$50,000 km x 8000 km; rate $\sim$60/day (Savcheva et al. 2007).

- Often have a “hot loop” at the jet’s base.
Coronal Hole Jets: “Minifilament eruptions”

“Normal” Filament Eruption (TRACE)
Minifilament-Eruption Model for (X-Ray) Jets


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)
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: \( \sim 10^{18} \text{ Mx/hr.} \)

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.
AR jets (Sterling et al. 2017)
What Causes Miniature-Filament Eruptions?

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

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- 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.
- 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.
Filament-Like Feature Eruptions on Smaller Scales??

Log “Filament” Size
Sterling & Moore (2016)
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,” ≲ 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 ≲ 0”.1 will revolutionize jet studies!

- **Cadence:**
  - AIA 12s adequate for many jets, so goal is **cadence ~5 s.**

- **Field of View:**
  - Jet bases ≲ 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!
An Example: AR Jets

- 14 Jan 2015 (NOAA AR 12259).
- AIA, HMI, Hinode, IRIS
- Sterling et al. (2017)
(Update to Bemporad et al. 2005 picture of “streamer puff” CMEs.)

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