

Solar Active Region Coronal Jets: Hidden-onset Jets



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Abstract Solar quiet- and coronal-hole region coronal jets frequently clearly originate from erupting minifilaments, but active-region jets often lack an obvious erupting-minifilament source. We observe a coronal-jet-productive active region (AR), AR12824, over 2021 May 22 0–8 UT, primarily using Solar Dynamics Observatory (SDO) Atmospheric Imaging Array (AIA) EUV images and SDO/Helioseismic and Magnetic Imager magnetograms. Jets were concentrated in two locations in the AR: on the south side and on the northwest side of the AR's lone large sunspot. The south-location jets are oriented so that we have a clear view of the jets' origin low in the atmosphere: their source is clearly minifilaments erupting from locations showing magnetic flux changes/cancelations. After erupting a projected distance $\sim 5''$ away from their origin site, the minifilaments erupt outward onto far-reaching field as part of the jet's spire, quickly losing their minifilament character. In contrast, the northwest-location jets show no clear erupting minifilament, but the source site of those jets are obscured along our line of sight by absorbing chromospheric material. EUV and magnetic data indicate that the likely source sites were $\sim 15''$ from where the we first see the jet spire; thus, an erupting minifilament would likely lose its minifilament character before we first see the spire. We conclude that such AR jets could work like non-AR jets, but the erupting-minifilament jet source is often hidden by obscuring material. Another factor is that magnetic eruptions making some AR jets carry only a harder-to-detect comparatively thin ($\sim 1''$ – $2''$) minifilament "strand." A full report appears in Sterling, Moore, & Panesar (2024, ApJ, 960, 109).

Overview

- Solar coronal jets are long, narrow geyser-like ejections usually observed in soft X-ray (SXR) or EUV coronal images (Shibata+1992, Sterling+2022). In coronal holes (CH; Fig. 1) they reach $\sim 50,000$ km, have widths ~ 8000 km, and lifetimes ~ 10 min (Savcheva+2007).
- In quiet Sun (QS) and CH regions, observations clearly show that many jets result from eruptions of small-scale filaments (minifilaments) (Fig. 1, Sterling+2015). This minifilament forms and erupts from a neutral line where flux cancelation occurs (Panesar+2016).
- For *Active Region* (AR) jets, an erupting minifilament (EMF) is sometimes *not* observed, and so there is a question of whether they work the same as QS and CH jets.
- To investigate this, we observe AR12824. This region produced numerous jets concentrated in two locations: on the S side and the NW side of the AR. The S-side jets clearly originate from EMFs at flux-cancelation sites. The NW-jets do not clearly show erupting minifilaments at their start. We investigate why the jets appear different.

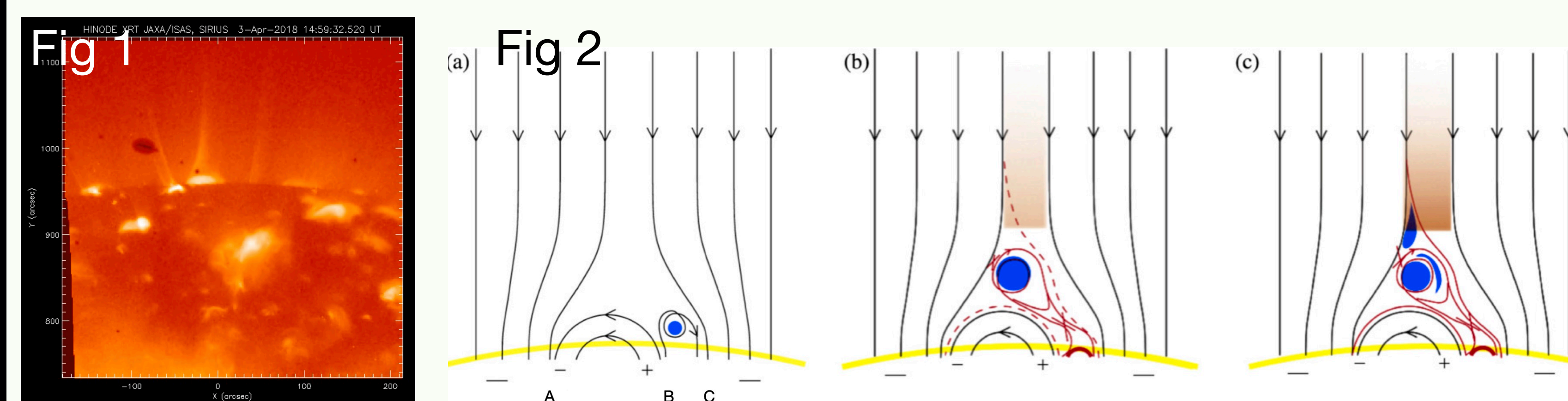


Fig. 1. Examples of polar CH jets, from Hinode/XRT (Sterling+2022).

Fig.2. Schematic picture of how jets work (Sterling+2015, 2018), showing magnetic field lines before (black) and after (red) reconnection, EMF (blue), JBP (red semicircle), the jet spire (orange), and magnetic polarities (+, -). See Sterling+2015 for details.

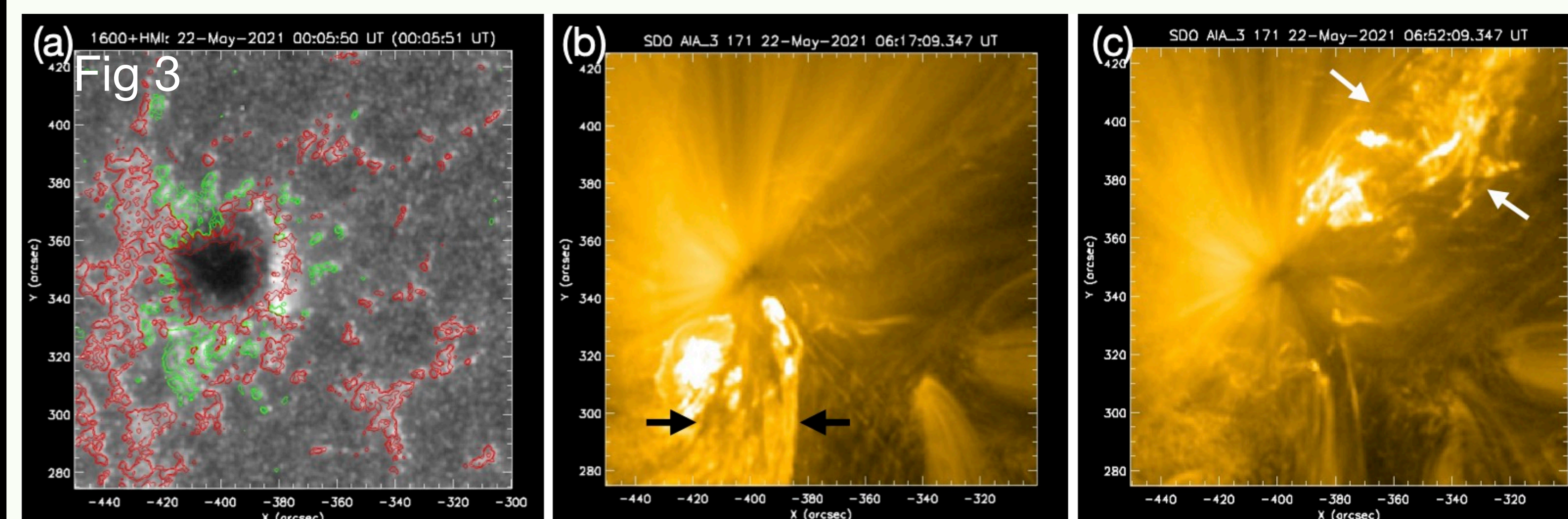


Fig.3. AR12824. (a) SDO/HMI magnetogram (red/green=pos/neg) overlaid onto an SDO/AIA 1600 Å image, showing an overview of the region. (b) A jet (black arrows) occurring south of the region's spot. (c) A jet (white arrows) occurring NW of the region's spot. Detailed inspection (Sterling+2024) shows EMFs leading to the S jets, but not to the NW jets.

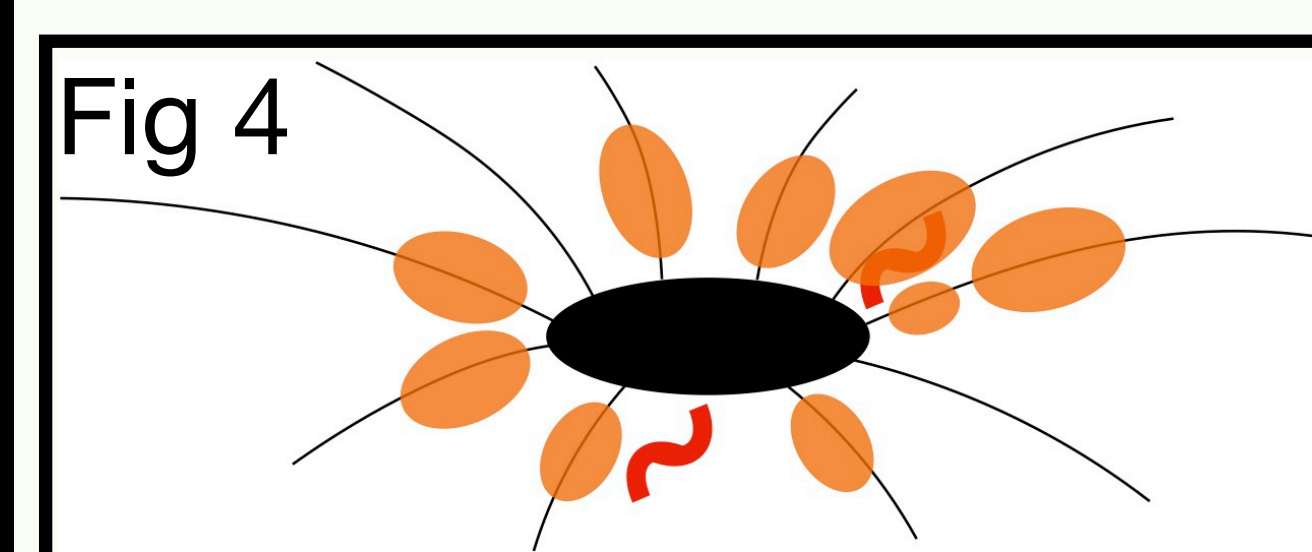


Fig.4. Schematic of AR12824, based on observations in AIA images/movies. The AR contains patchy chromospheric material that obscures the lower atmosphere in some wavelengths. The S jets occur where we can see between patches and observe the EMFs (red curve), while in the NW the patches obscure possible EMFs.

Discussion

- In CHs and QS, many jets clearly result from EMFs, but in AR jets such EMFs are frequently not obvious. AR12824 produced many jets; those in the S clearly started from EMFs, but not those in the NW.
- The base location of the NW jets is obscured by patches of absorbing chromospheric material suspended in the low atmosphere. For the S jets we see the EMFs in between patches.
- The S jets' EMFs occur at sites of flux cancelation, like many CH and QS jets. Those EMFs form jet spires after moving horizontally $\sim 5''$. For the NW jets, we see canceling-flux $\sim 5''$ away that are likely sites of EMFs hidden by absorbing material.
- We suspect that all jets form as in Fig. 2, but sometimes the EMFs are hidden.

Panesar+2016, ApJ, 862L, 7

Sterling+2018, ApJ, 864, 68

Savcheva+2007, PASJ 59, 771

Sterling+2022, ApJ, 927, 127

Shibata+1992, PASJ, 44, L173

Sterling+2024, ApJ, 960, 109

Sterling+2015, Nature, 523, 437

Supported by NASA's HGI, HSR, and HSOC Programs, and by the NASA/MSFC Hinode Project.