Origin of Pre-Coronal-Jet Minifilaments: Flux Cancellation

Navdeep K. Panesar¹,
Alphonse Sterling¹, Ronald Moore¹,²

¹NASA, Marshall Space Flight Center, Huntsville, AL
²Center for Space Plasma and Aeronomic Research (CSPAR), UAH, Huntsville, AL
Background

- Coronal jets are frequent magnetically channeled narrow eruptions.
- All coronal jets observed in EUV and X-ray images show a bright spire with a base brightening, also known as jet bright point (JBP).
- Recent studies of jets show that coronal jets are driven by small-scale filament eruptions (e.g. Hong et al. 2011, Shen et al. 2012, Adams et al. 2014, Sterling et al. 2015).
- We recently investigated the triggering mechanism of ten ondisk quiet-region coronal jet eruptions and found that magnetic flux cancellation at the neutral line of *minifilaments* is the main cause of quiet-region jet eruptions (Panesar et al. 2016).

**What leads to the formation of these pre-jet minifilaments?**
We investigate the magnetic field evolution that leads to pre-jet minifilament formation.

Measured parameters for the observed quiet-region pre-jet minifilaments:

<table>
<thead>
<tr>
<th>Event No.</th>
<th>Minifil. formation time (UT)</th>
<th>Minifil. eruption time (UT)</th>
<th>Location</th>
<th>Duration of eruption (hrs)</th>
<th>Width of minifil. (km)</th>
<th>No. of Jets</th>
<th>$\Phi$ values</th>
<th>% of $\Phi$ reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>2012 Mar 21 22:46</td>
<td>2012 Mar 22 04:46</td>
<td>S09, E29</td>
<td>6</td>
<td>2000±500</td>
<td>1</td>
<td>1.6</td>
<td>20 ± 6.8</td>
</tr>
<tr>
<td>J2</td>
<td>2012 Jul 01 05:58</td>
<td>2012 Jul 01 08:29</td>
<td>N12, E02</td>
<td>2.5</td>
<td>1500±200</td>
<td>1</td>
<td>1.9$^h$</td>
<td>20 ± 7.3</td>
</tr>
<tr>
<td>J4</td>
<td>2012 Aug 04 05:14</td>
<td>2012 Aug 05 01:58$^i$, 2012 Aug 05 02:20</td>
<td>N07, E30</td>
<td>21</td>
<td>2500±500</td>
<td>2</td>
<td>5.8</td>
<td>14 ± 4.6</td>
</tr>
<tr>
<td>J5</td>
<td>2012 Aug 10 19:43</td>
<td>2012 Aug 10 23:03</td>
<td>S31, E11</td>
<td>3.2</td>
<td>1500±200</td>
<td>1</td>
<td>0.9</td>
<td>27 ± 6.1</td>
</tr>
<tr>
<td>J6</td>
<td>2012 Sept 19 17:15</td>
<td>2012 Sept 20 22:52</td>
<td>S34, E11</td>
<td>34</td>
<td>2500±500</td>
<td>2</td>
<td>3.0</td>
<td>9 ± 5.3</td>
</tr>
<tr>
<td>J7</td>
<td>2012 Sept 21 00:51</td>
<td>2012 Sept 21 03:33</td>
<td>S34, E08</td>
<td>3.5</td>
<td>2500±500</td>
<td>1</td>
<td>1.7</td>
<td>38 ± 2.6</td>
</tr>
<tr>
<td>J8</td>
<td>2012 Sept 21 23:55</td>
<td>2012 Sept 22 01:25</td>
<td>N01, E20</td>
<td>1.5</td>
<td>1500±500</td>
<td>1</td>
<td>0.9</td>
<td>38 ± 5.5</td>
</tr>
<tr>
<td>J10</td>
<td>2012 Dec 13 08:06</td>
<td>2012 Dec 13 10:11, 2012 Dec 13 10:36</td>
<td>S01, W01</td>
<td>2.5</td>
<td>1600±200</td>
<td>2</td>
<td>1.2</td>
<td>7.0 ± 8.3</td>
</tr>
</tbody>
</table>

Minifilament Formation (J2)
Minifilament Formation (J2)

- Duration of minifilament ~ 2.5 hours.
- Brightenings appear at the location where the minifilament subsequently forms.
Minifilament Formation and Flux Cancelation
Homologous Jet Eruptions (J6 and J7)

- We also observe more than a single jet from the same neutral line. A minifilament erupts and drives a jet, reforms/reappears at the same location, and then again erupts, driving the next jet.

- This process occurs as flux cancelation is ongoing and continues until all the minority-polarity flux vanishes. Eventually, the neutral line disappears, no more minifilaments and homologous jets are produced.
Homologous Jet Eruptions (J6 and J7)
Continuous flux cancelation between a minority-polarity flux clump and a majority-polarity flux clump builds a highly sheared minifilament field, leading to the formation of a minifilament.

These results are consistent with the models for the formation of the field of typical solar filaments (van Ballegooijen & Martens 1989; Martens & Zwaan 2001).
Summary

- We examined in detail the formation mechanism of ten random on-disk quiet-region pre-jet minifilaments.

- We found that flux cancelation is the key agent responsible for building a highly sheared minifilament field, leading to the formation of minifilaments. Sometimes continuous flux cancelation results in homologous eruptions.

- Persistent flux cancelation at the neutral line finally destabilizes the field holding the minifilament, and that field then erupts to make a coronal jet.

- Our observations supports that quiet region flux cancelation results in both the formation of the pre-jet minifilament and its jet-driving eruption.