A Series of Jets that Drove Streamer-Puff CMEs from Giant Active Region of 2014

Navdeep K. Panesar[1,2], Alphonse C. Sterling[1], and Ronald L. Moore[1,2]

[1]Heliophysics and Planetary Science Office, ZP13, Marshall Space Flight Center, Huntsville, AL

[2]Center for Space Plasma and Aeronomic Research (CSPAR), UAH, Huntsville, AL

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Abstract

We investigate characteristics of solar coronal jets that originated from active region NOAA 12192 and produced coronal mass ejections (CMEs). This active region produced many non-jet major flare eruptions (X and M class) that made no CME. A multitude of jets occurred from the southeast edge of the active region, and in contrast to the major-flare eruptions in the core, six of these jets resulted in CMEs. Our jet observations are from multiple SDO/AIA EUV channels, including 304, 171 and 193Å, and CME observations are taken from SOHO/LASCO C2 coronograph. Each jet-driven CME was relatively slow-moving (~200 - 300 km s^{-1}) compared to most CMEs; had angular width (20° – 50°) comparable to that of the streamer base; and was of the "streamer-puff" variety, whereby a preexisting streamer was transiently inflated but not removed (blown out) by the passage of the CME. Much of the chromospheric-temperature plasma of the jets producing the CMEs escaped from the Sun, whereas relatively more of the chromospheric plasma in the non-CME-producing jets fell back to the solar surface. We also found that the CME-producing jets tended to be faster in speed and longer in duration than the non-CME-producing jets. We expect that the jets result from eruptions of minifilaments. We further propose that the CMEs are driven by magnetic twist injected into streamer-base coronal loops when erupting twisted minifilament field reconnects with the ambient field at the foot of those loops. For more details see *Panesar et al. 2016*.

Evolution of a Jet and CME

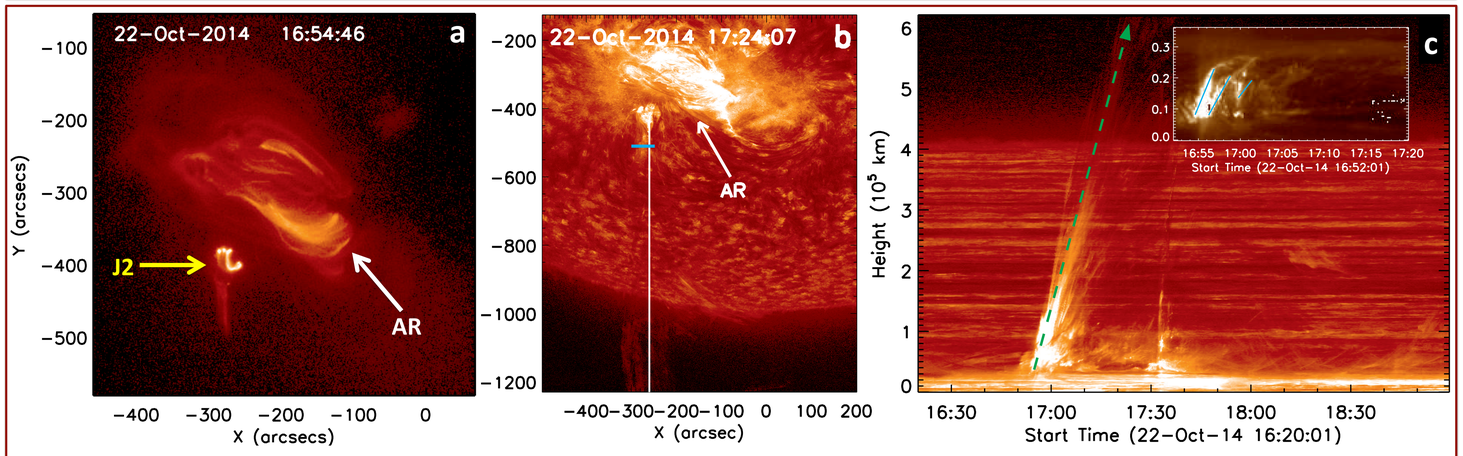


Fig.1. An erupting jet (J2) observed on 22 Oct 2014: (a) Hinode/XRT image; (b) SDO/AIA 304 Å intensity image. The white line in (b) marks the position of the time-distance plot in (c). Panel (c) shows the 304 Å intensity height-time-series image along the vertical line in (b); inset in (c) shows the 193 Å intensity time-series image along the blue line in (b); it shows motion consistent with untwisting of the jet. The green dashed arrow in (c) is the path used to estimate outflow speed of the plasma.

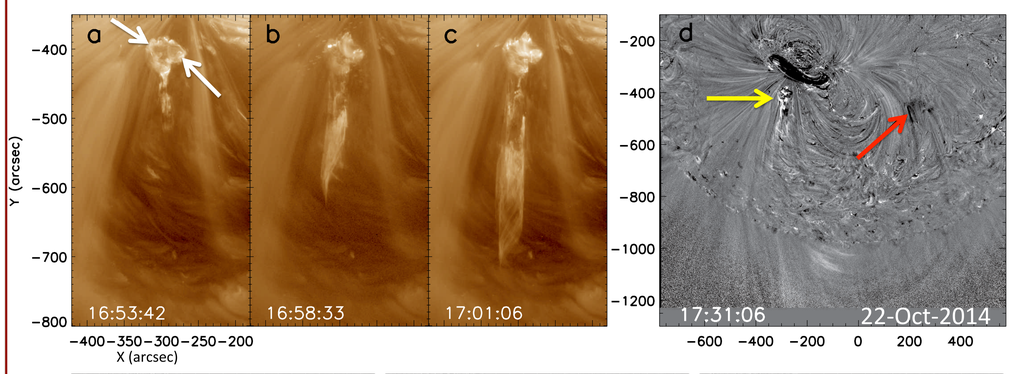


Fig.2. 193 Å intensity time-series images of J2 (a-c); the arrows point to the flare brightening in the jet base during the rise phase of the jet. Panel (d) shows the 193 Å base difference image; the red and yellow arrows point to the remote dimming and jet-origin region, respectively.

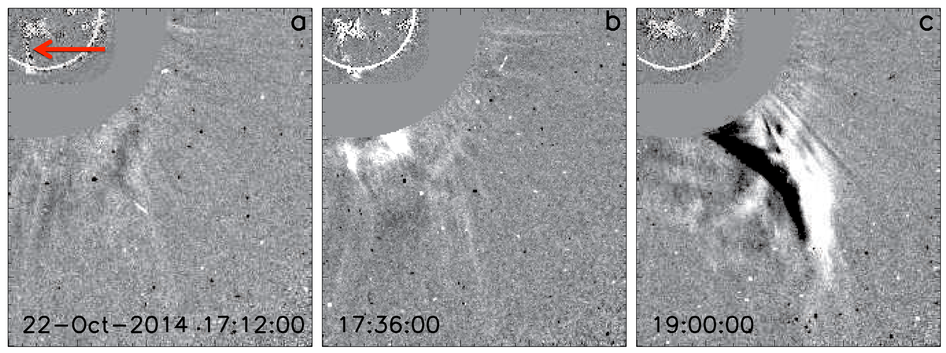


Fig.3. Progression of CME: LASCO C2 running-difference images showing the streamer-puff CME from jet J2. In each frame, SDO/AIA 193 Å running-difference image is co-aligned with the C2 image. The red arrow in (a) points to the J2 jet.

Date and time for the observed jets

(a) CME-producing Jets

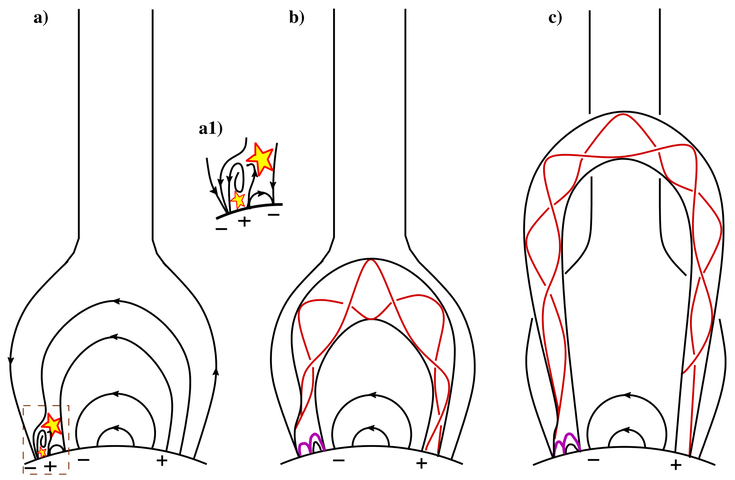
Jet No	Date (UT)	Time[a]	Flare Class	CME Speed[b,c] (km s^{-1})	CME Angular Width (°)	Jet Speed[d] (km s^{-1})	Jet Rise Dur. (±5 minute)	Jet Width[e] (±1500 km)	Remote Bri. and Dim.
J1	20 Oct 14	18:43	C6.2	187	40	190 ± 10	20	34000	Yes
J2	22 Oct 14	16:52	C5.8	281	20	310 ± 20	30	38000	Yes
J3	23 Oct 14	19:11	C3.3	239	35	330 ± 20	50	26000	No
J4	24 Oct 14	03:56	C3.6	250	30	300 ± 20	45	34000	Yes
J5	24 Oct 14	07:37	M4.0	677	50	400 ± 40	35	86000	Yes
J6	27 Oct 14	17:33	M1.4	186	25	ambiguous[f]	…	…	…[g]

(b) Non-CME-producing Jets:

J8	22 Oct 14	02:31	…	…	…	75 ± 10	35	19000	…
J9	22 Oct 14	05:51	…	…	…	120 ± 20	10	15000	…
J10	22 Oct 14	10:46	C1.9	…	…	140 ± 20	15	11000	…
J11	22 Oct 14	12:56	…	…	…	50 ± 10	20	16500	…
J12	22 Oct 14	17:30	C3.0	…	…	ambiguous[h]	10	13000	…
J13	22 Oct 14	20:11	C3.0	…	…	150 ± 20	10	16000	…
J14	22 Oct 14	23:15	C1.1	…	…	110 ± 10	25	13000	…

Interpretation

- The jet bipole resides in the streamer base.
- The jet-producing region contains a sheared field that holds a minifilament (*Sterling et al. 2015*).
- Eventually the filament field becomes unstable and erupts, and undergoes external reconnection (big star).



- External reconnection transfers the twist to the guide loop. The twist-loaded loop of the streamer base expands and erupts to become the 'streamer-puff CME' (*Bemporad et al. 2005*).
- The CME-producing jets are faster in speed (300 ± 75 km s^{-1}), longer in duration (35 minutes), wider in size (43,000 km) than the non-CME-producing jets. The properties of our jets are typical of active-region jets (*Shimojo et al. 1996)*.

References

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