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

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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 SDO/AIA EUV channels and from Hinode/XRT, and CME observations are from the 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

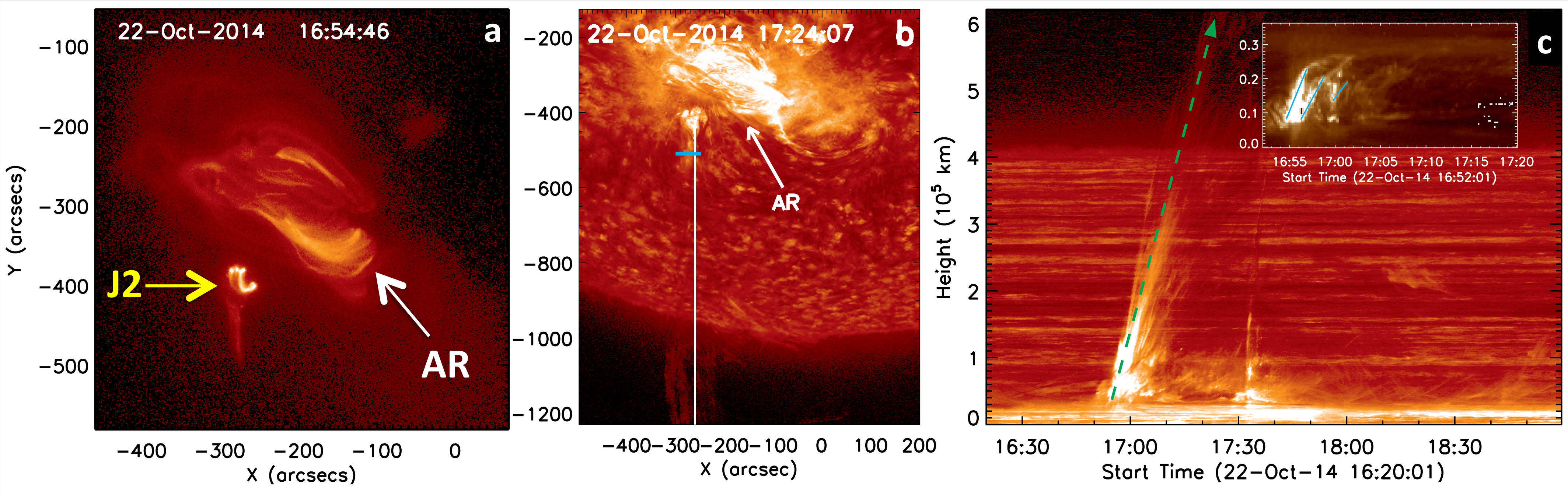


Fig.1. An erupting jet (J2, Table 1) observed on 22 Oct 2014: (a) Hinode/XRT BeThin image; (b) SDO/AIA 304 Å intensity image. Panel (c) shows the 304 Å intensity height-time-series image along the vertical line in (b); inset in (c) shows the 193 Å intensity time-series along the blue line in (b), displaying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

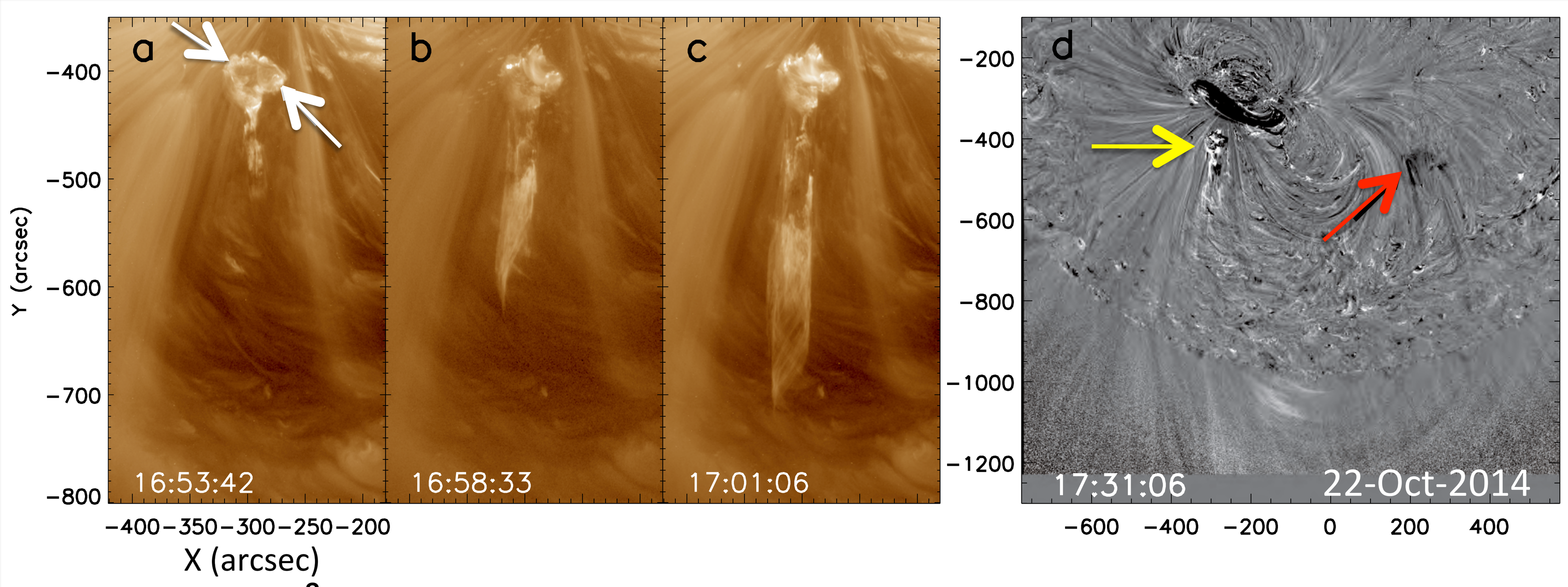


Fig.2. 193 Å intensity time-series images of J2 (Table 1) (a-c); arrows point to the flare brightening in the jet base during the rise phase of the jet. Panel (d) shows a 193 Å base difference image; the red and yellow arrows point to remote dimming and the jet-origin region, respectively.

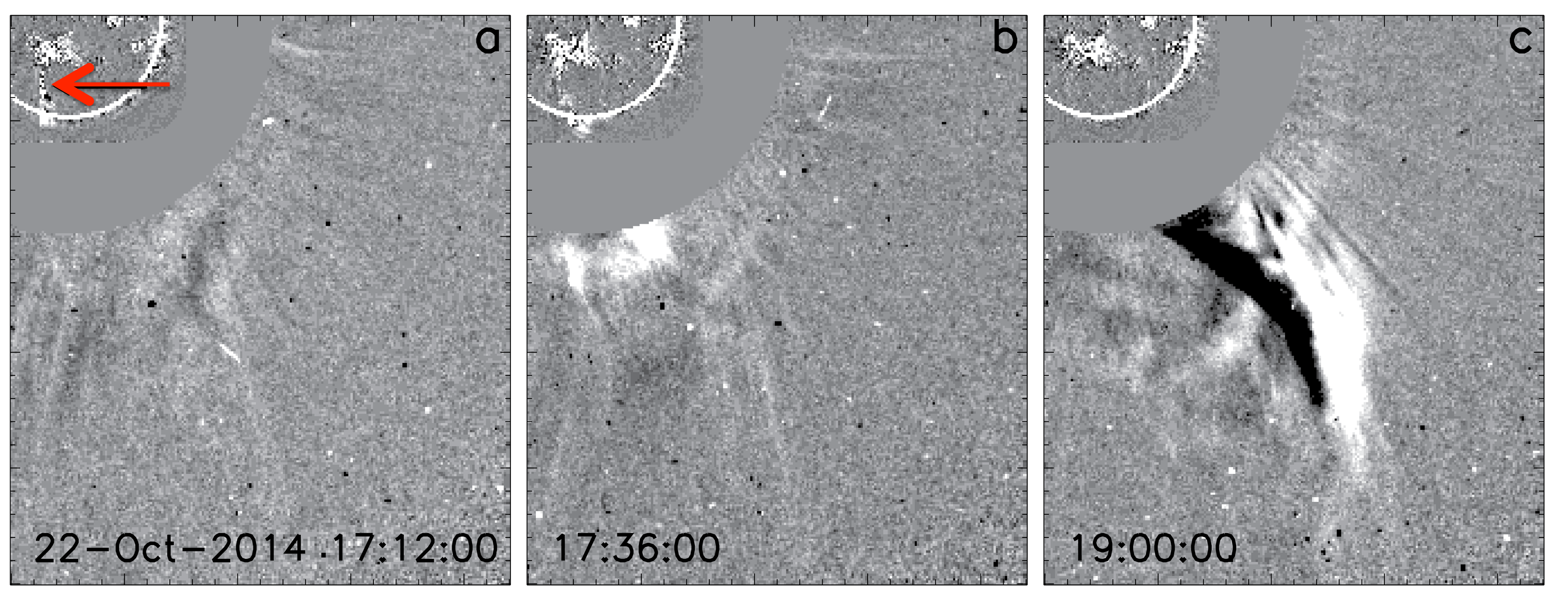


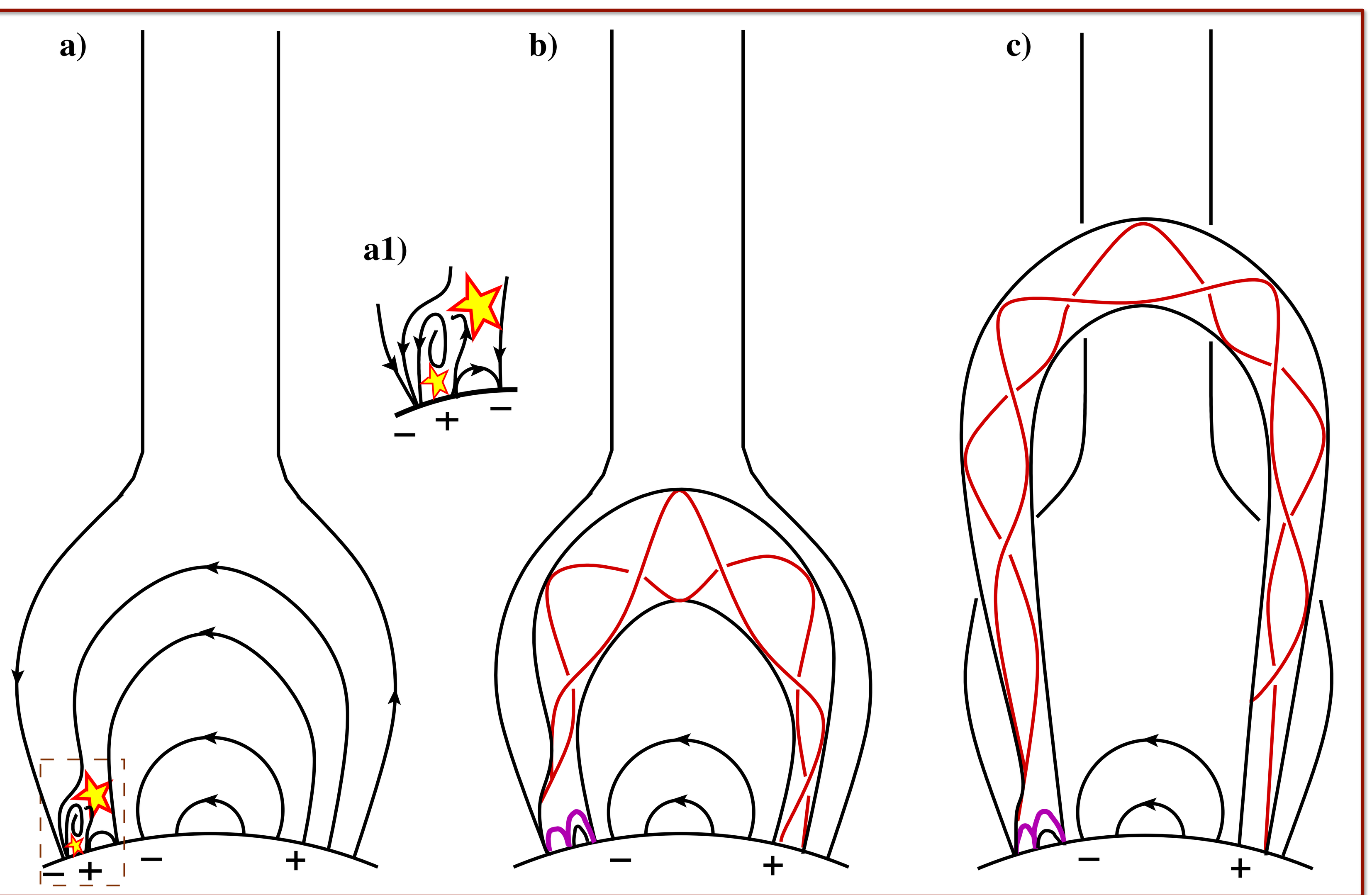
Fig.3. Progression of CME: LASCO C2 running-difference images showing the streamer-puff CME from jet J2 (Table 1). In each frame, a SDO/AIA 193 Å running-difference image is co-aligned with the C2 image. The red arrow in (a) points to the J2 jet.

Table 1: Properties of observed 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.
(a) CME-producing Jets									
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 of the minifilament field to the streamer-base 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), and 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*).



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