IRIS and SDO Observations of Solar Jetlets Resulting from Flux Cancelation

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Contributed Talk

4. Eruptions in the solar atmosphere

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Solar jets of all sizes are magnetically channeled narrow eruptions; the larger ones are often observed in the solar corona in EUV and coronal X-ray images. Recent observations show that the buildup and triggering of the minifilament eruptions that drive coronal jets result from magnetic flux cancelation under the minifilament, at the neutral line between merging majority-polarity and minority-polarity magnetic flux patches. Here we investigate the magnetic setting of on-disk small-scale jets (also known as jetlets; small jets of base widths 2-3",∼10 times smaller than typical base widths of classical coronal jets) in a coronal hole by using IRIS and SDO/AIA images and line-of-sight magnetograms from SDO/HMI. We observe recurring jetlets at the edges of the magnetic network in the coronal hole. From magnetograms co-aligned with the IRIS and AIA images, we find that the jetlets stem from sites of flux cancelation between merging majority-polarity and minority-polarity flux patches, and that the jetlets show brightenings at their bases reminiscent of the base brightenings in coronal jets. Based on these observations of ∼10 obvious jetlets and our previous observations of ∼50 coronal jets in quiet regions and coronal holes, we infer that flux cancelation is the essential process in the buildup and triggering of jetlets. Our observations suggest that jetlet eruptions are small-scale analogs of both larger-scale coronal jet eruptions and the still-larger-scale eruptions that make major CMEs.

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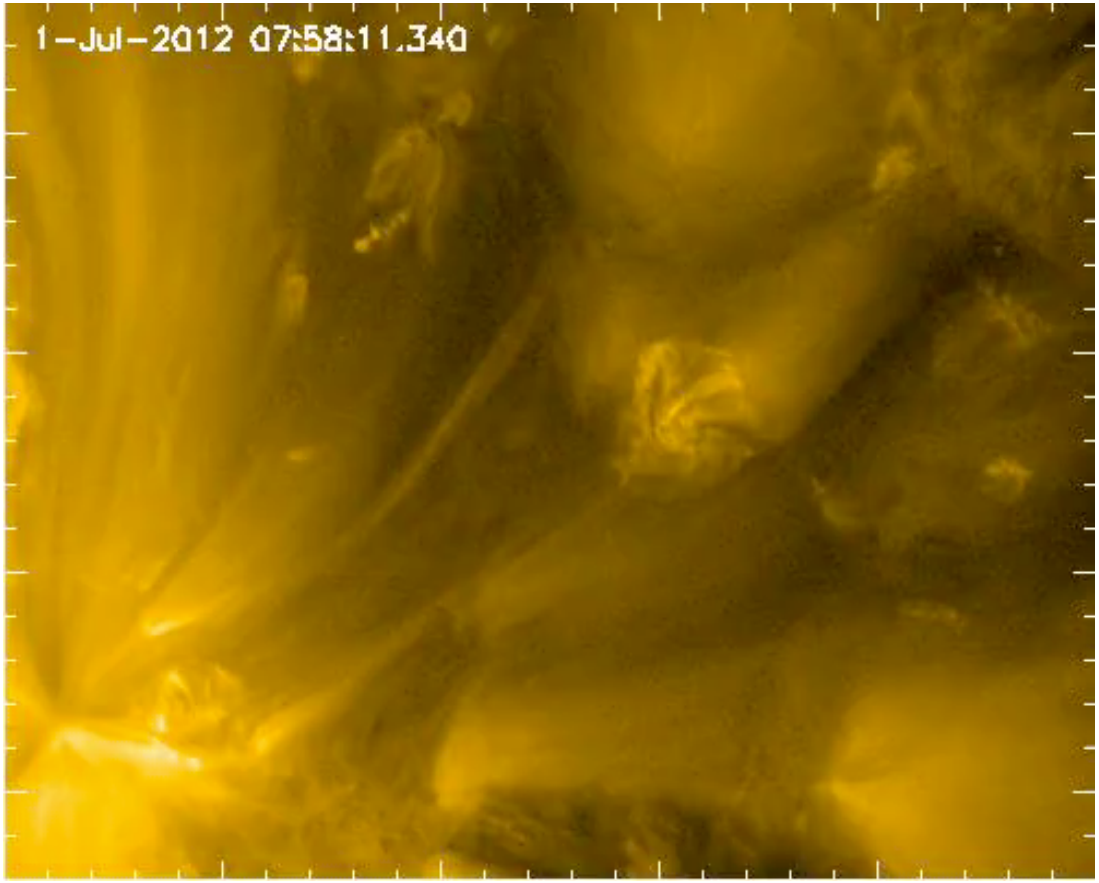
Background



- Jets of all sizes are frequent magnetically channeled narrow eruptions. They occur in various solar environments: quiet regions, coronal holes and active regions.

- All coronal jets observed in UV, EUV and X-ray images show a bright spire with a base brightening, also known as jet bright point (JBP).

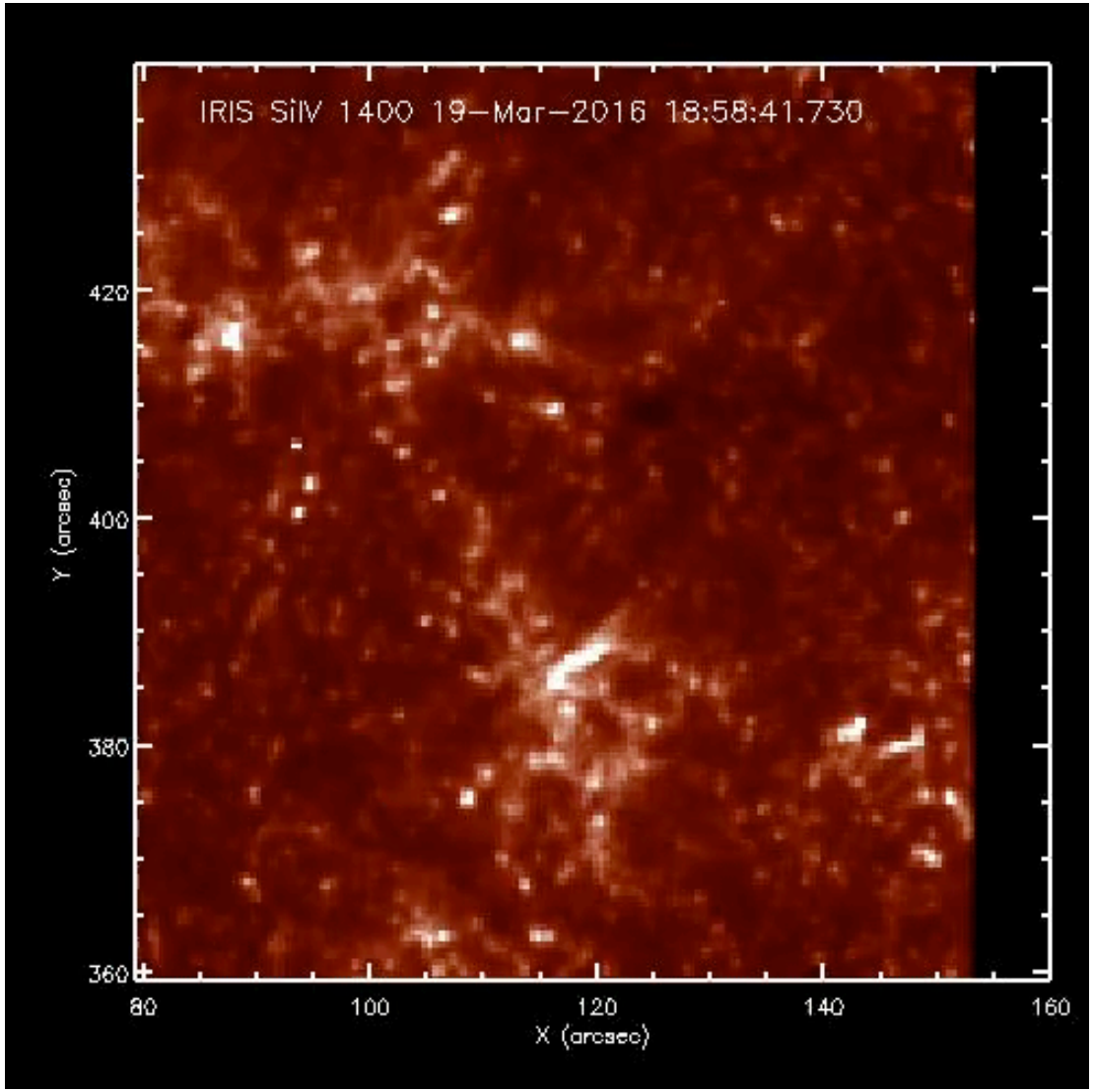
- Recent studies show that coronal jets are driven by small-scale filament eruptions (e.g. *Hong et al. 2011, Shen et al. 2012, Adams et al. 2014, Sterling et al. 2015*).

- We found in on disk quiet regions (*Panesar et al. 2016b*) and coronal holes (*Panesar et al. 2018*) that coronal jets originate at a neutral line between dominant-polarity flux and a patch of canceling minority-polarity flux.

- Small-scale jets (***jetlets***) have been observed in SDO/AIA images, at flux cancelation sites at the plume footpoints (*Raouafi & Stenborg 2014*).

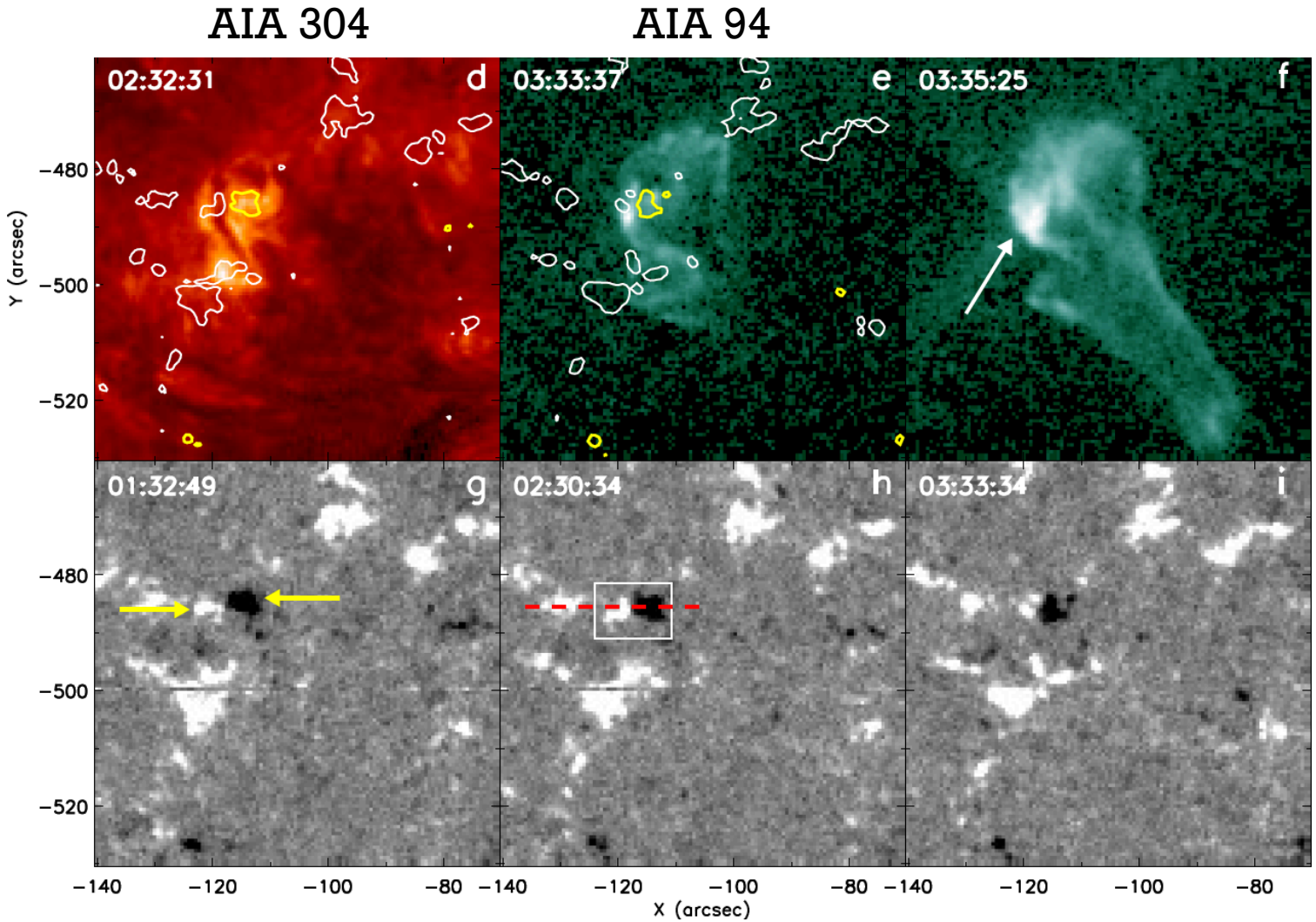
- Whether these jetlets work in the same fashion as larger coronal jets still an open question.

- We investigate the triggering mechanism of 10 on-disk jetlets in a coronal hole network region using IRIS and SDO data.



(*Panesar et al. 2018 in prep*)

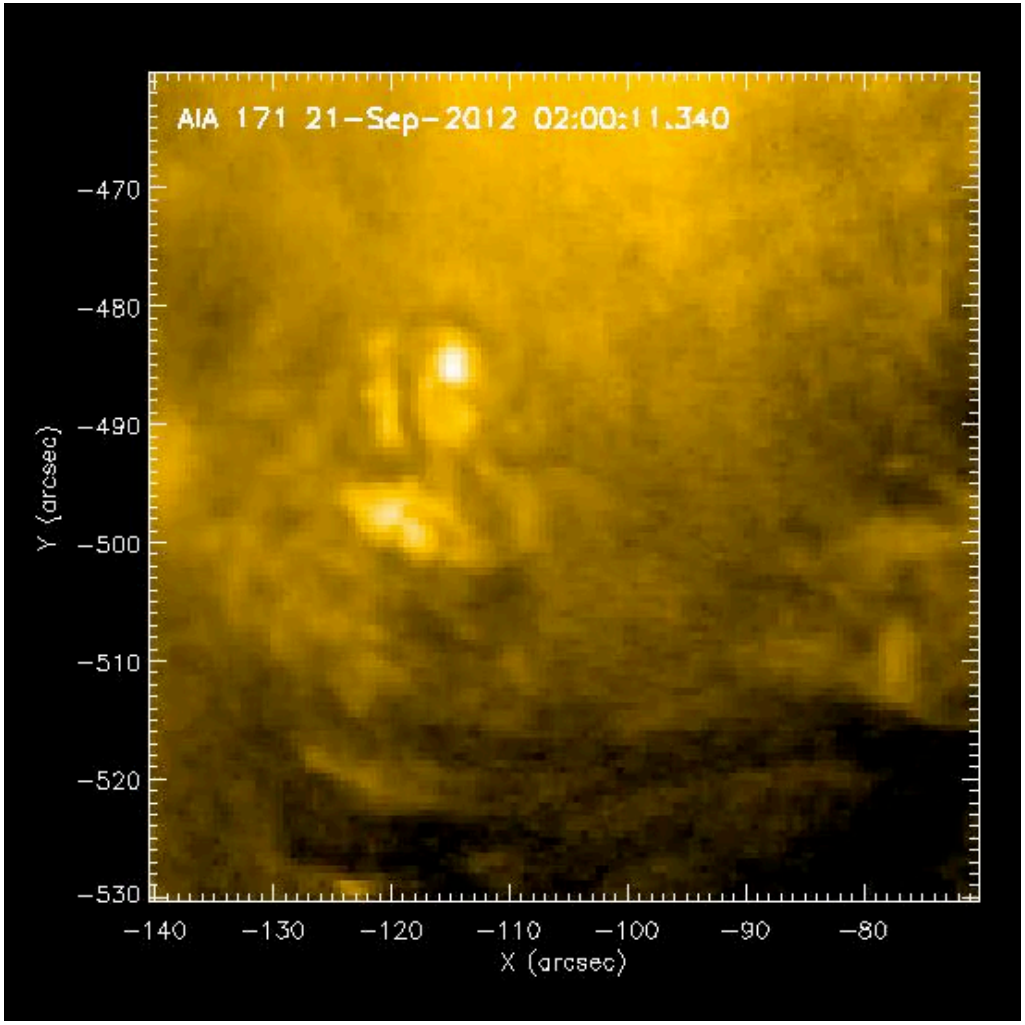
Quiet region jet (J7)

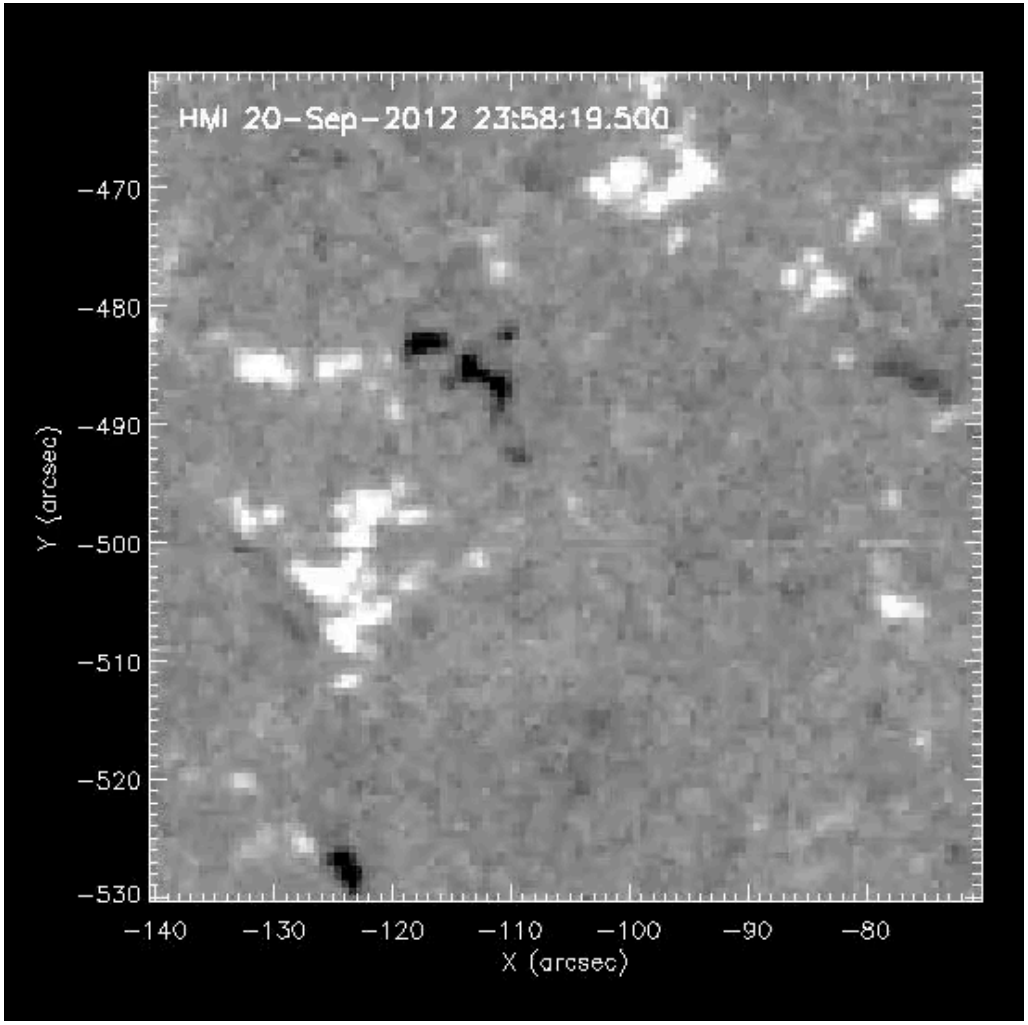


- A minifilament (length ~15000 km) is present in the jet-base region prior to jet eruption.
- It resides over the neutral line between the opposite-polarity flux patches.
- The JBP occurs at the pre-eruption location of the minifilament.
- The jet spire extends upward with an average speed of 135±30 kms^{-1}.

Panesar, Sterling, Moore, Chakrapani, 2016b, ApJ, 832, L

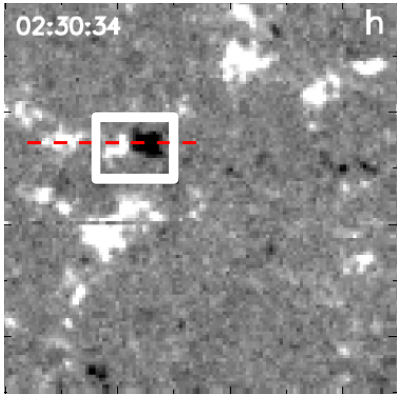
Quiet region jet (J7)

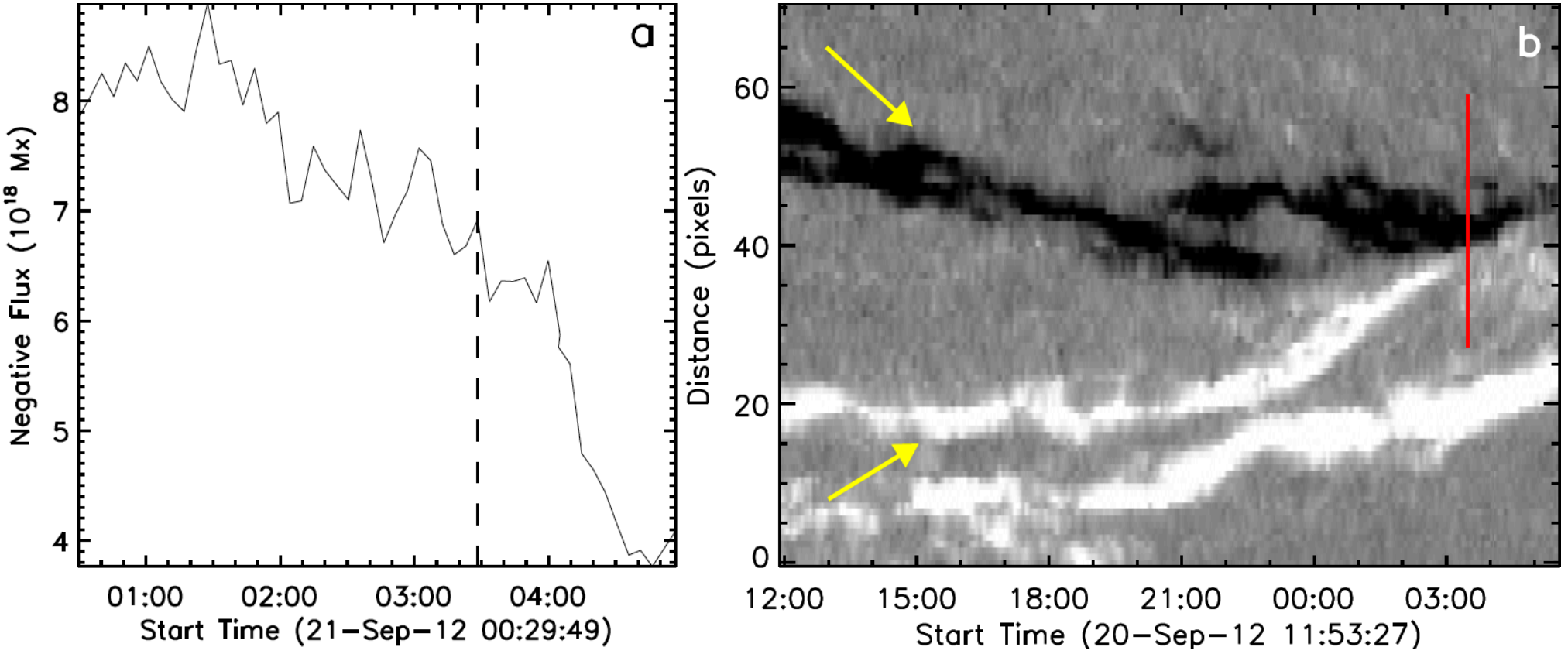




- The minifilament was present at the neutral line for 34 hours before the jet eruption.
- The jet-producing eruptions and JBPs are similar to typical solar flare eruption, in which a flare arcade grows over the neutral line in the wake of the filament.

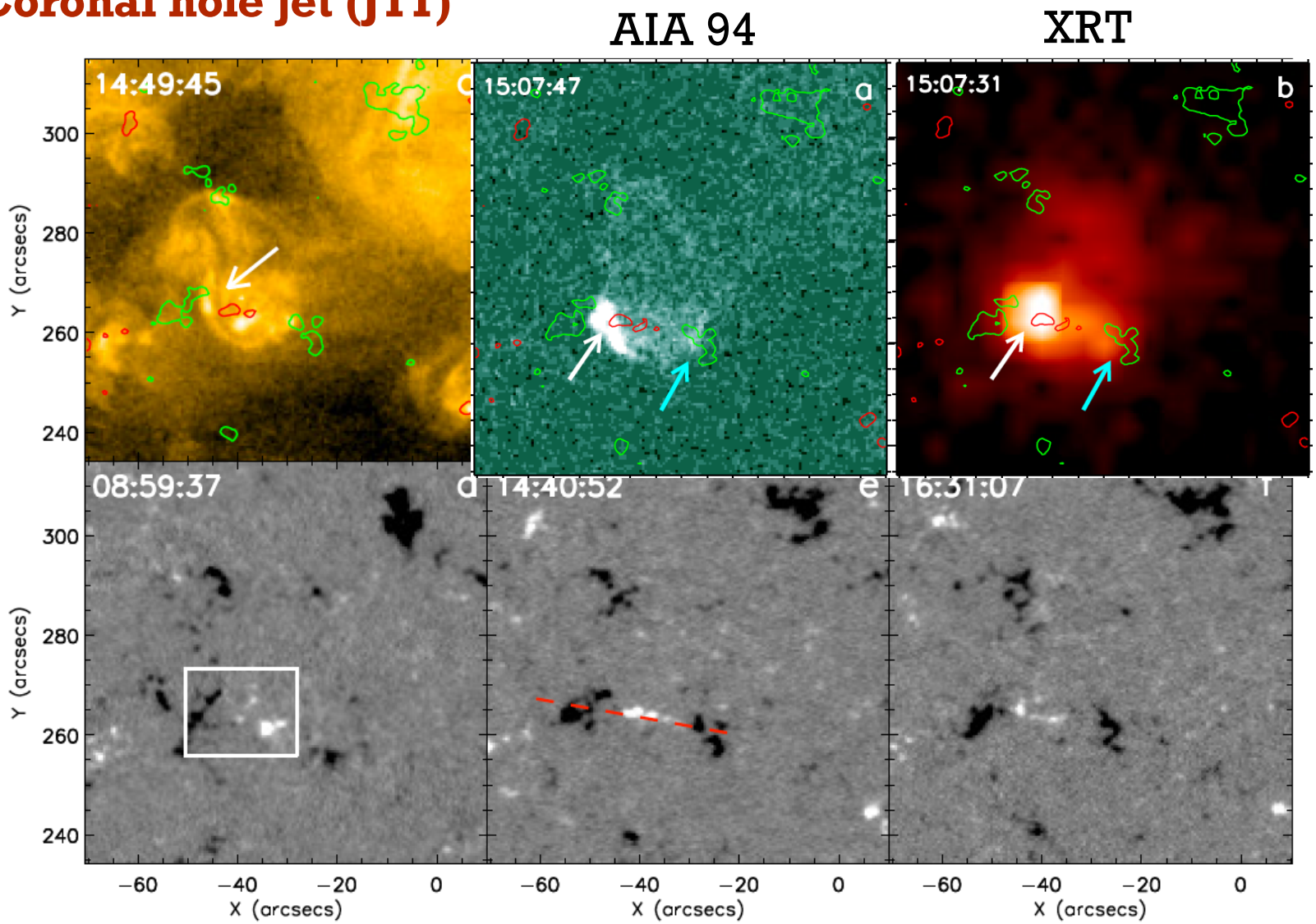
Flux cancelation leading to minifilament eruption





- Both polarities approach towards the neutral line, and eventually cancel with each other just before the eruption. Flux cancelation continued until the minority-polarity flux patch completely disappeared.
- We find in each of the ten jets that opposite polarity magnetic flux patches converge and cancel, with a flux reduction of 20-60% until jet erupts.

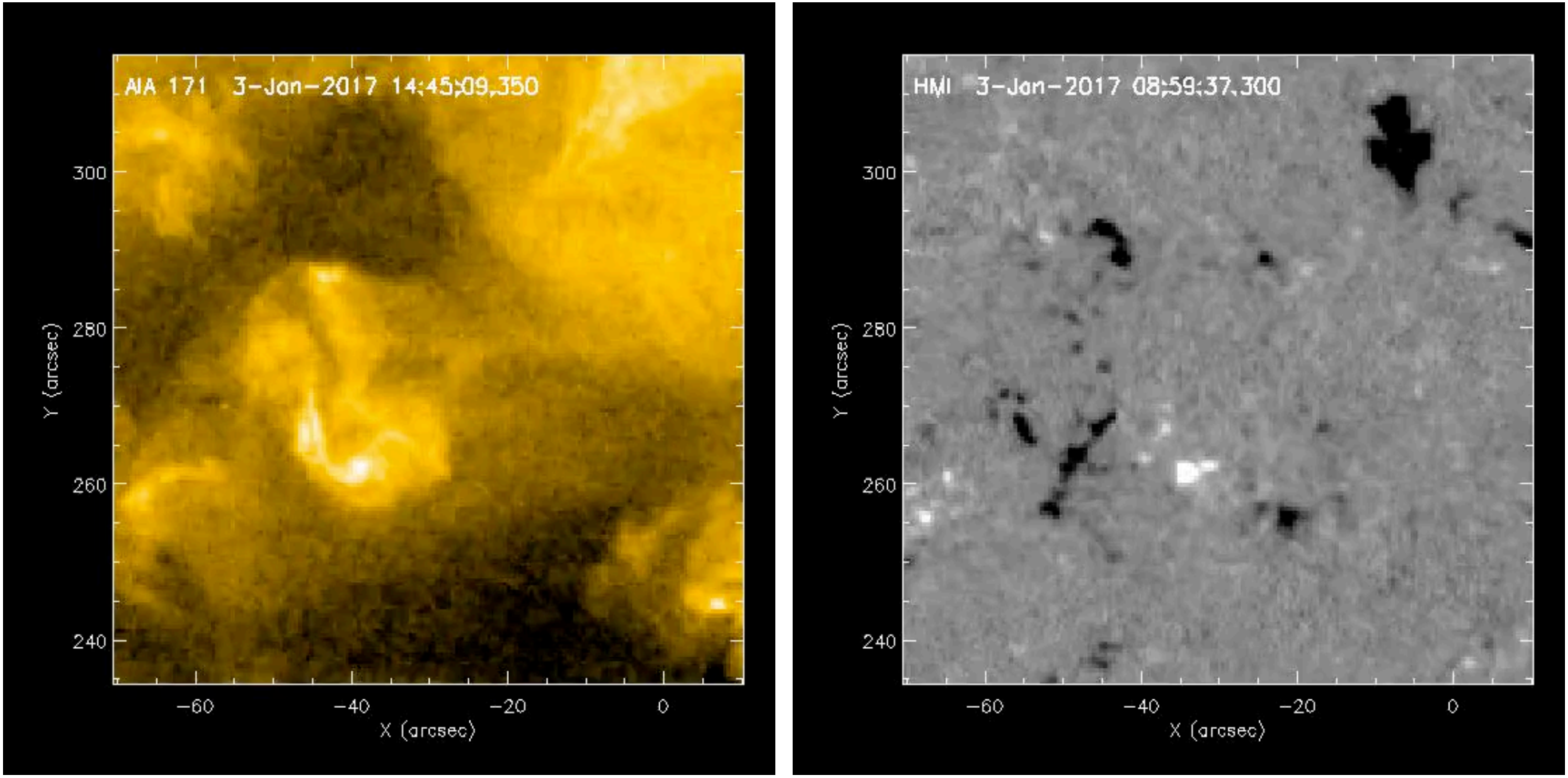
Coronal hole jet (J11)



- A minifilament resides (1 hour before the eruption) over the neutral line between the opposite-polarity flux patches.
- The JBP occurs at the pre-eruption location of the minifilament.
- The jet spire extends upward with an average speed of 105±30 kms^{-1}.

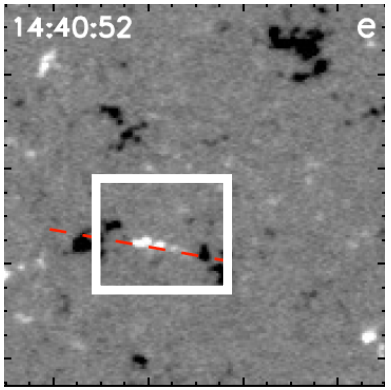
Panesar, Sterling, Moore, 2018, ApJ, 853…89P

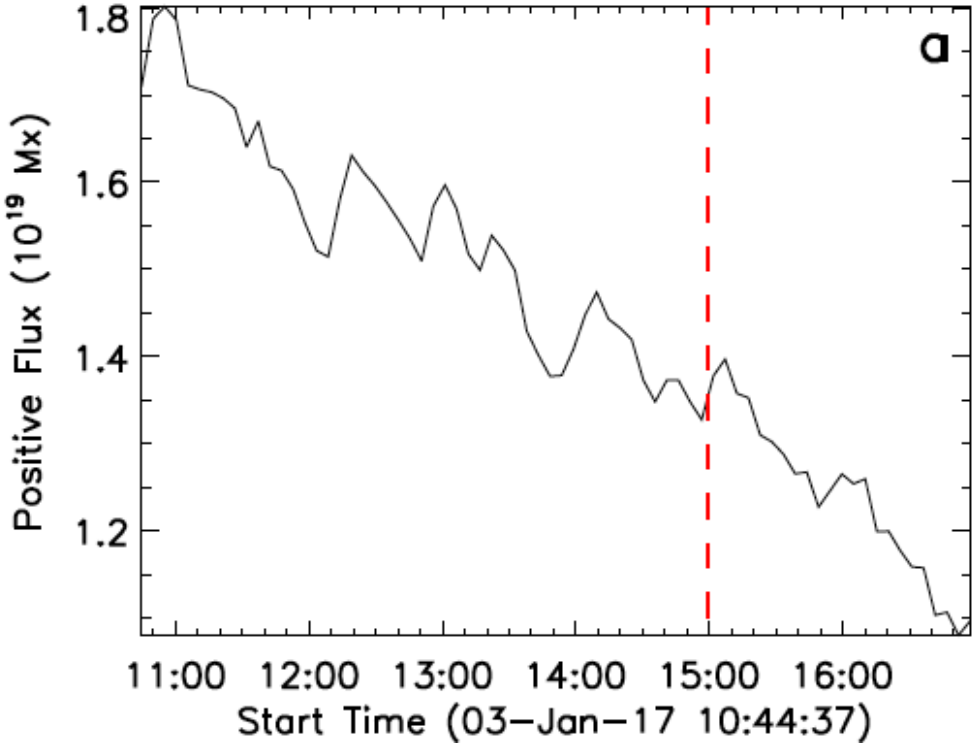
Coronal hole jet (J11)

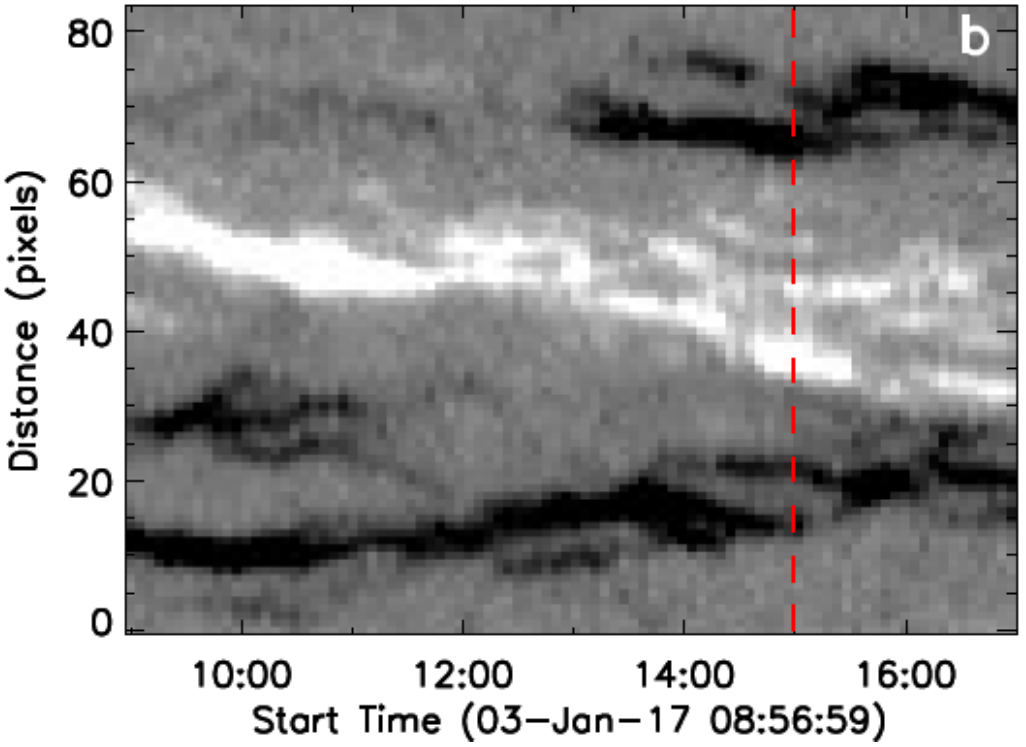


- The jet-producing eruptions and JBPs are similar to typical solar flare eruption, in which a flare arcade grows over the neutral line in the wake of the filament.

Flux cancelation leading to minifilament eruption

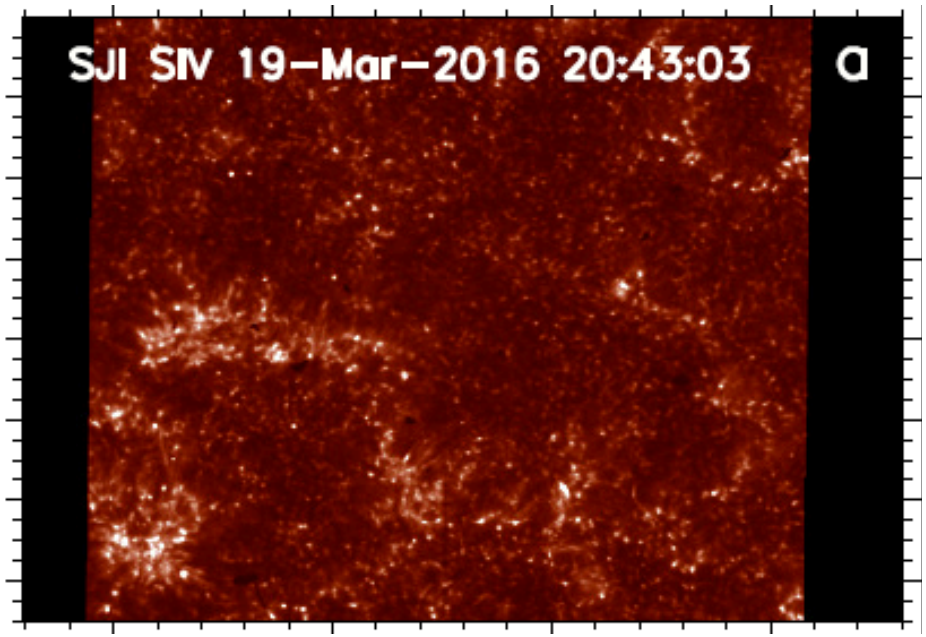


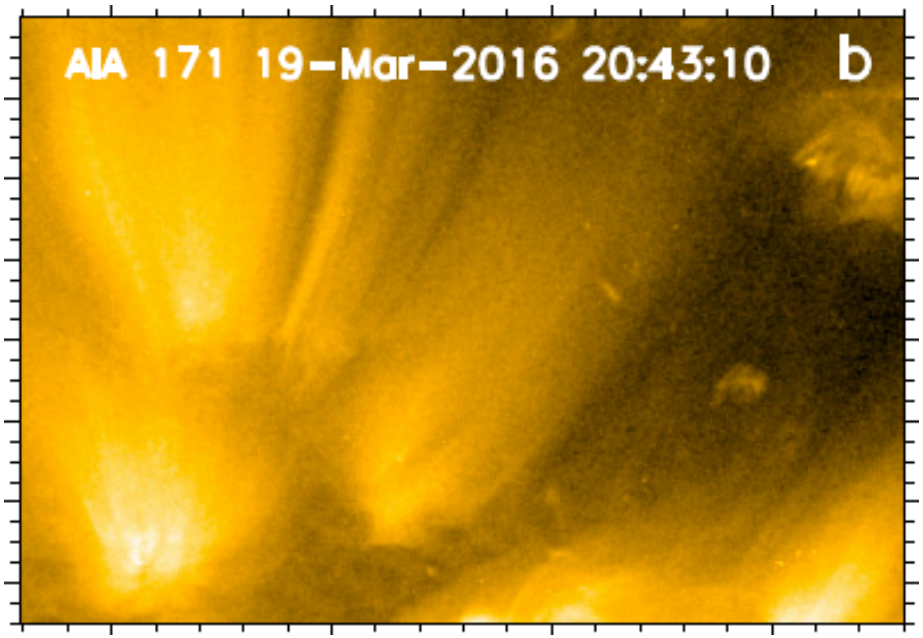


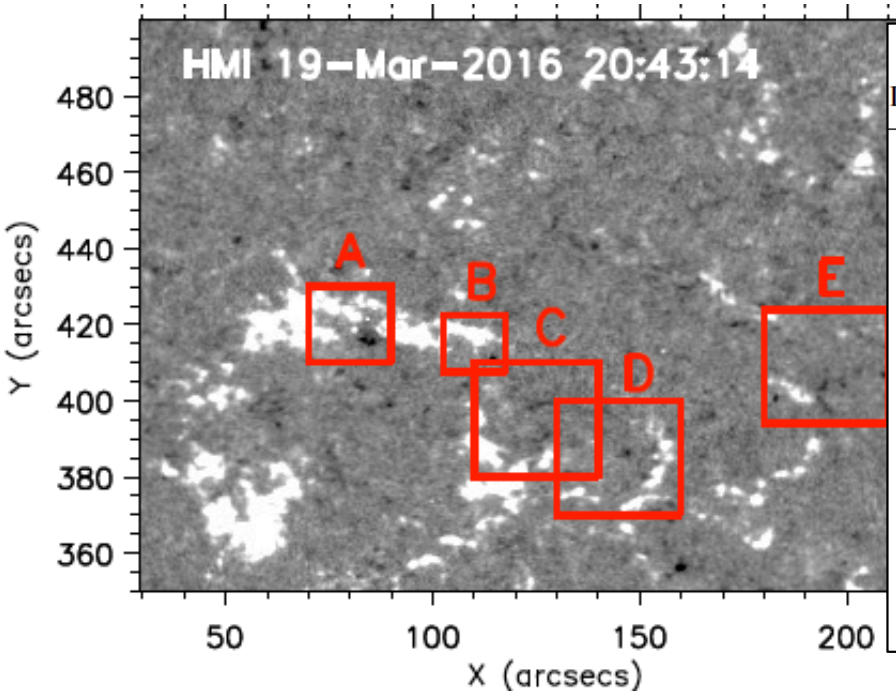


- The positive flux continuously decreases with time, which is clear evidence of flux cancelation at the neutral line of the minifilament.
- We find in each of the 13 jets that opposite polarity magnetic flux patches converge and cancel, with a flux reduction of 20-75% until jet erupts.

IRIS Jetlets: We find 10 jetlets in a network region, at five different locations.

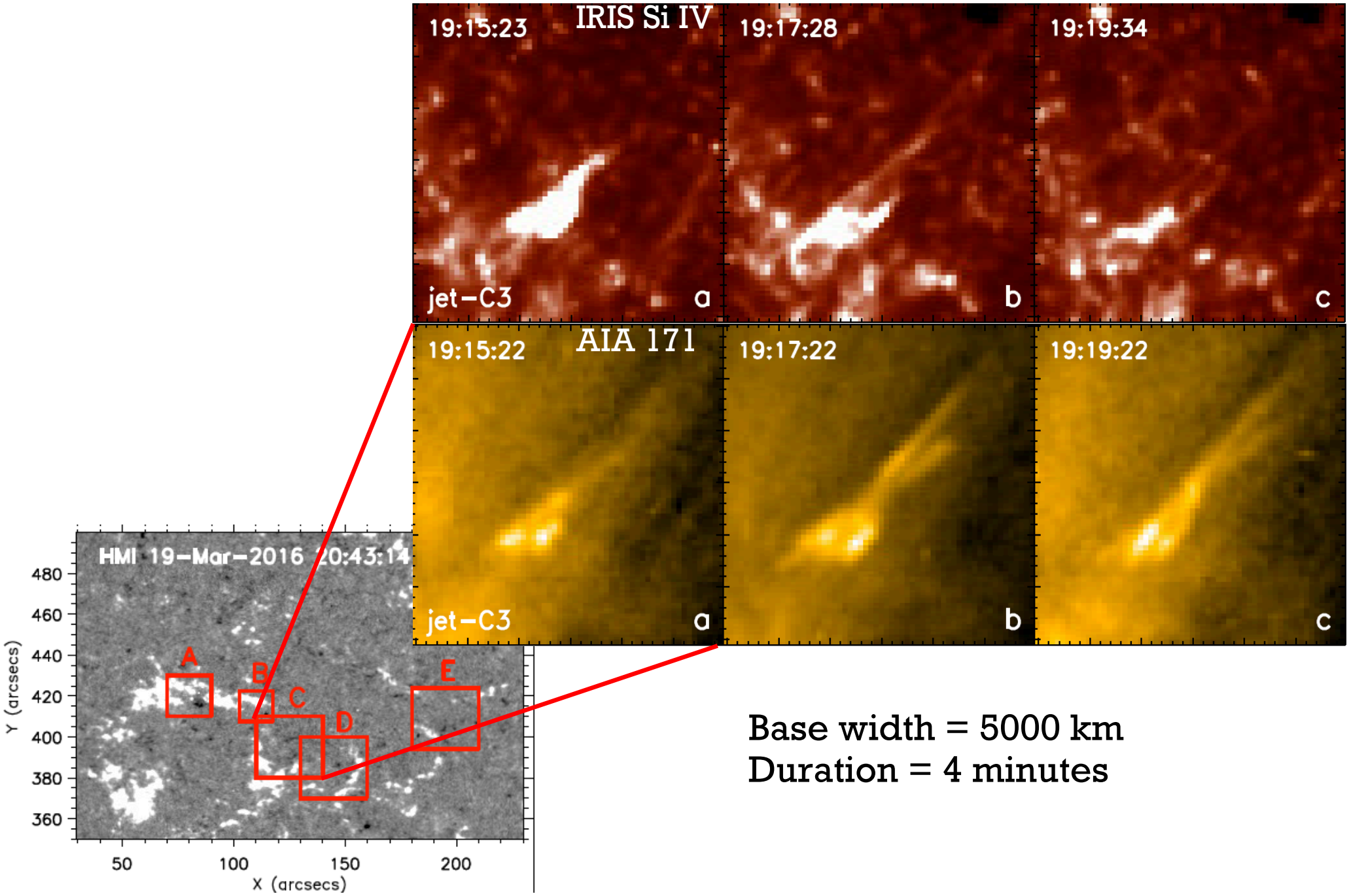






Jetlet Location	No. of Jetlets	Time[a] (UT)	IRIS Coverage	Jetlet Speed[b] (km s^{-1})	Jetlet Dur.[c] (minutes)	Jetlet-Base[d] Width (km)	Φ Cancelation[e] rates 10^{18} $Mxhr^{-1}$
A	1	22:07	No	23±1	4±12s	3200±500	1.0
B	2	13:57,	No	-	2±24s	2200±500	-
		19:04	Yes	-	2±12s	2100±200	-
C	3	16:40,	No	110±25	2±12s	2500±400	1.7
		18:33,	Yes	-	3±24s	3000±300	
		19:15	Yes	120±50	4±24s	5000±800	
D	1	19:15	Yes	50±20	3±12s	4300±200	2.6
E	3	21:16,	Yes	70±30	3±12s	10,000±1000	0.6
		22:37,	No	60±10	4±24s	5000±300	
		23:14	No	50±10	5±12s	6500±200	

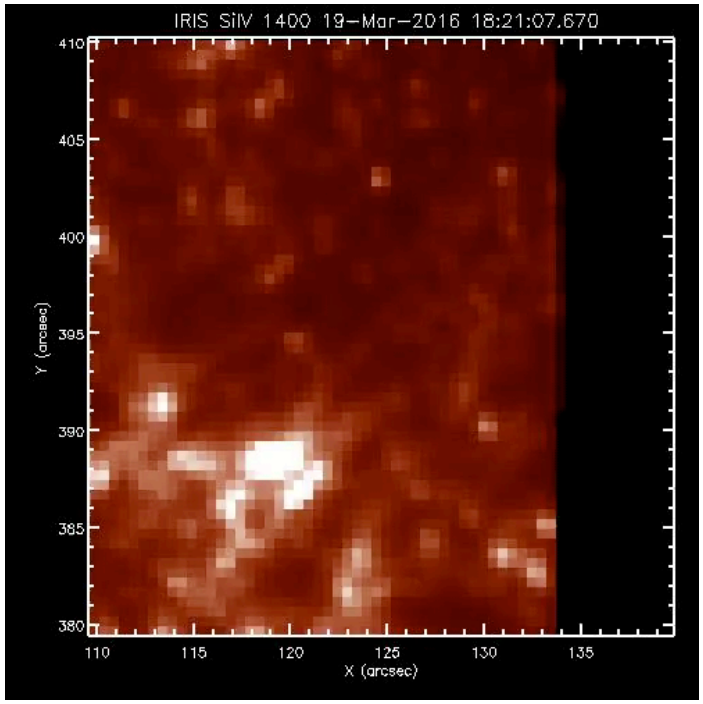
Jetlet-C3



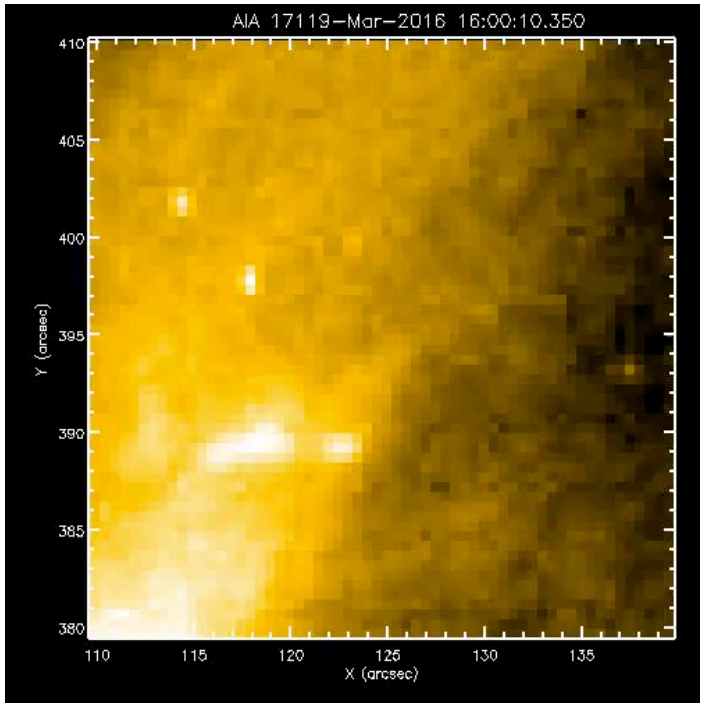
Base width = 5000 km
Duration = 4 minutes

Jetlet-C3

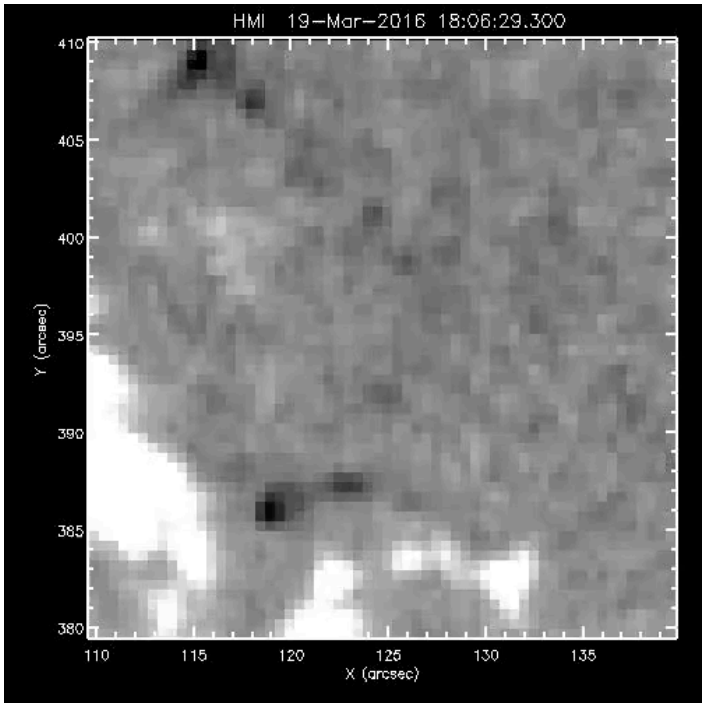
IRIS Si IV



AIA 171

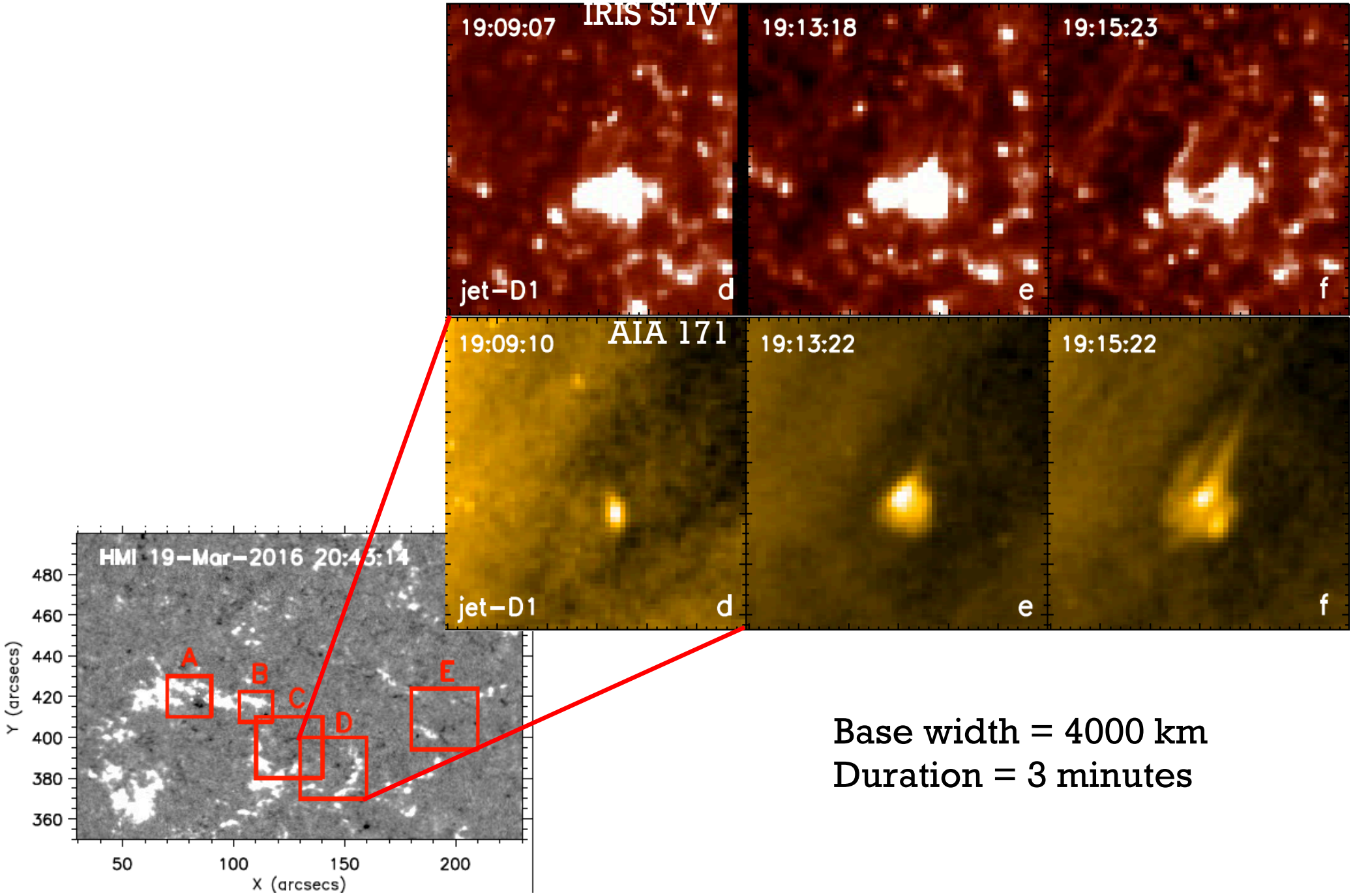


HMI



- We find three jetlet eruptions from the same neutral line due to continuous flux cancelation. Minifilaments in homologous coronal jets have also been observed to erupt and reform at the same neutral line due to flux cancelation (*Panesar et al. 2017*).

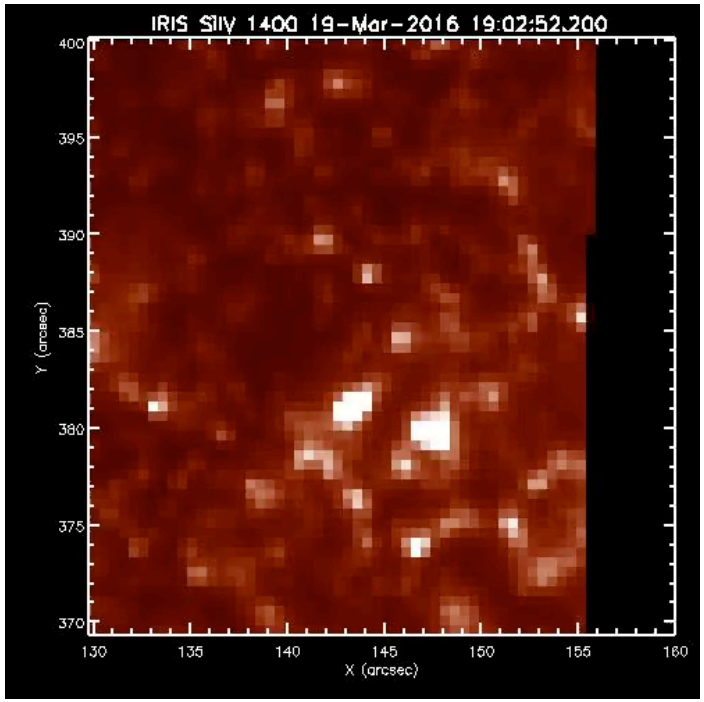
Jetlet-D1



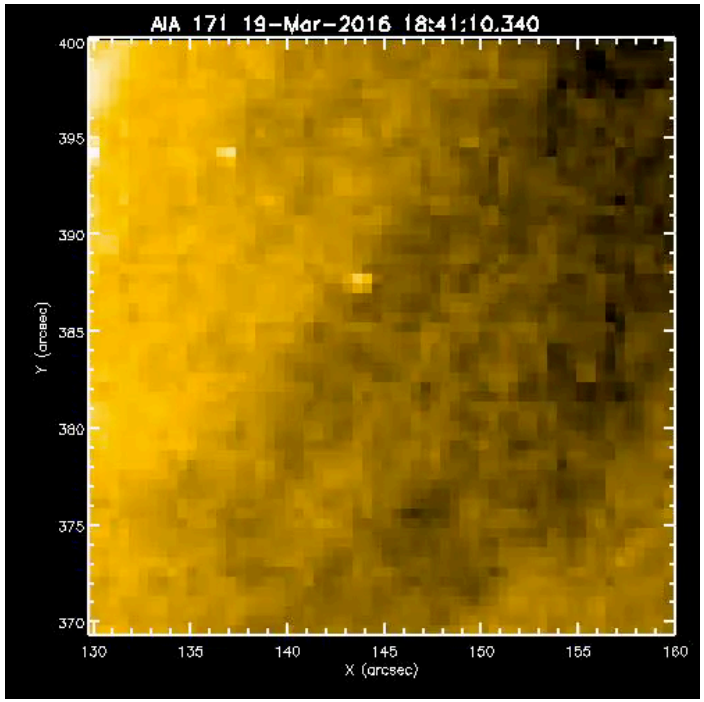
Base width = 4000 km
Duration = 3 minutes

Jetlet-D1

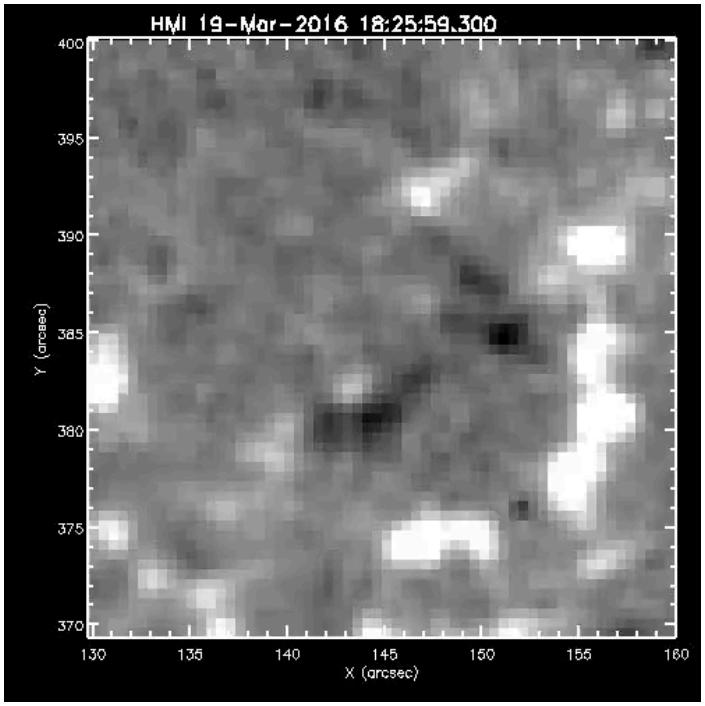
IRIS Si IV



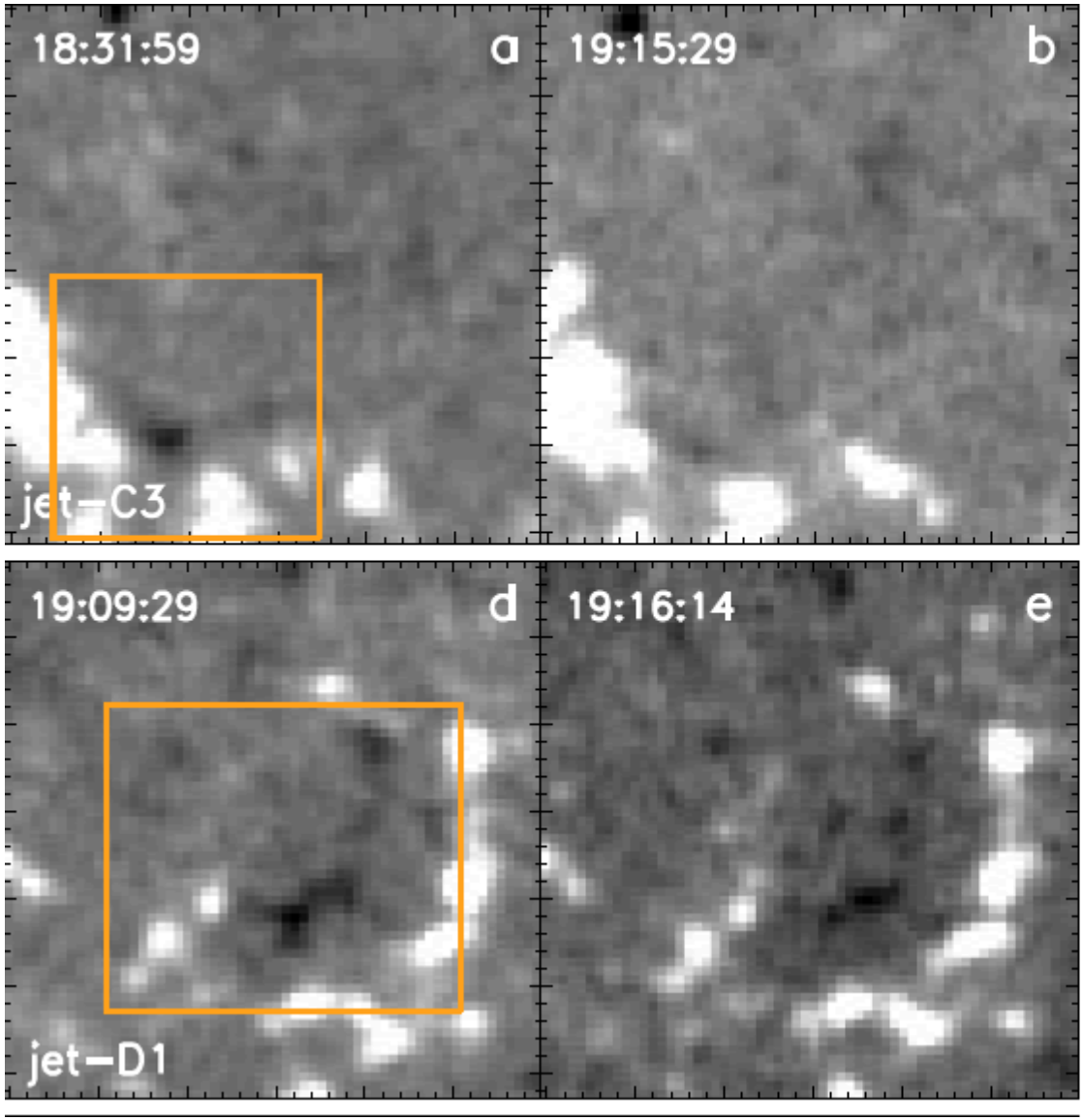
AIA 171

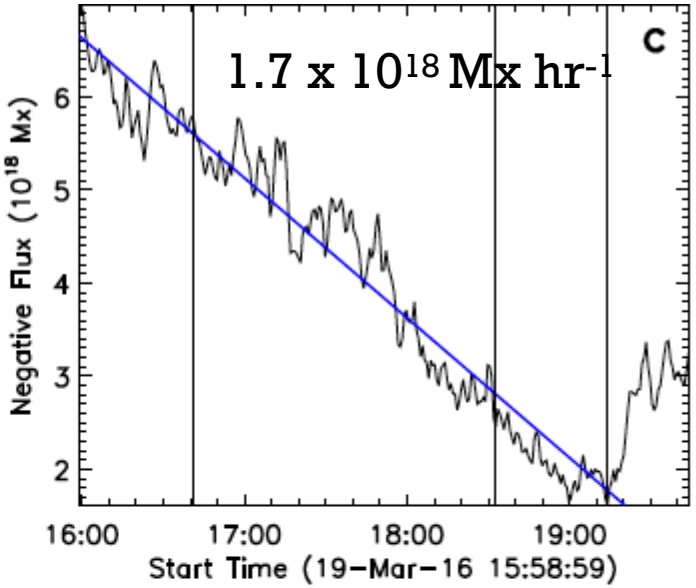


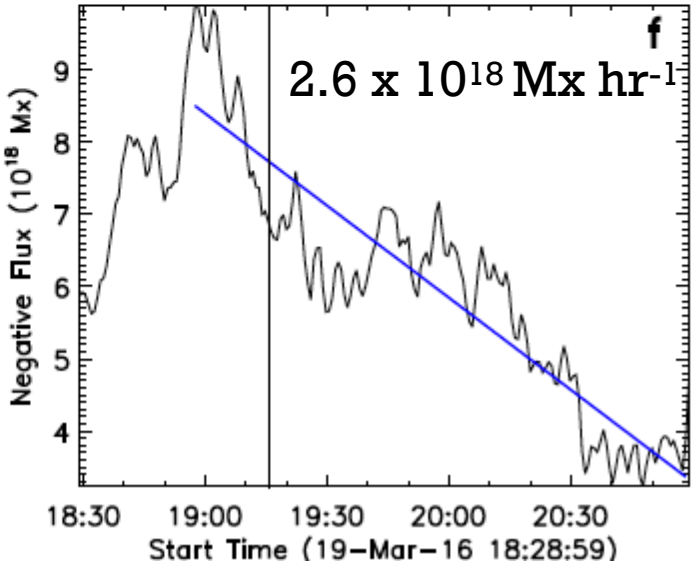
HMI



Flux cancelation leading to Jetlets







Summary and Conclusion

- We examined in detail a coronal hole network region observed by IRIS and SDO.
- We find 10 jetlets that occur at the edges of magnetic network flux lanes, at five different locations and they show brightenings at their bases reminiscent of base brightenings in coronal jets.
- Jetlets are several times smaller (base width ~5,000 km) than typical coronal jets (~18,000 km).
- HMI magnetograms show that at least most of these jetlets occur from the sites of flux cancelation between a majority-polarity flux network flux lane and a merging minority-polarity flux clump.
- Evidently, these jetlet eruptions are analogous to larger-scale coronal jet eruptions (*Panesar et al. 2018, in prep*).