

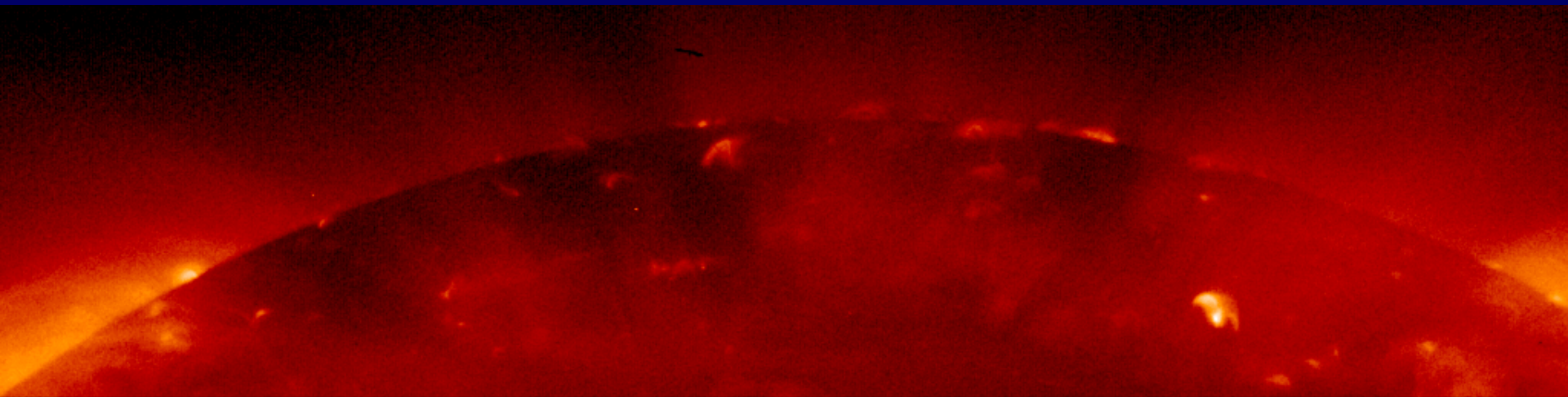
Reconnecting Current Sheets in the Corona

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Coronal Jets:

- Most common example of fast reconnection in the solar corona
- Physically similar to CMEs/eruptive flares: slow energy buildup and explosive release via reconnection
- **First observations of plasmoids (3D B-islands) in jet current sheet**

Hinode/XRT images of coronal hole jets

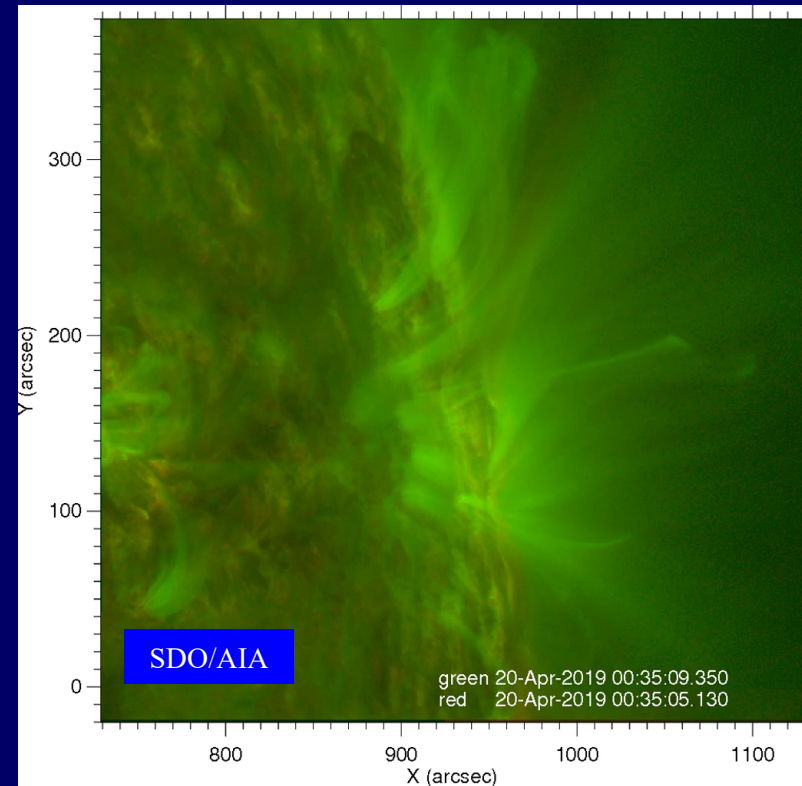
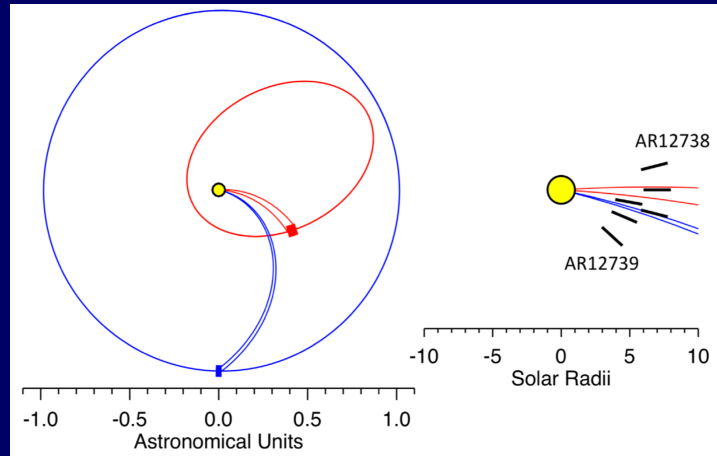


First ^3He -Rich SEP Events From Parker Solar Probe

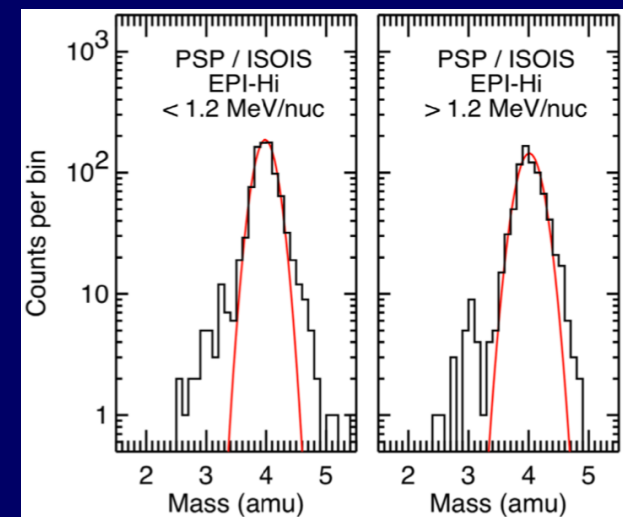
Wiedenbeck et al. 2020

- Helical jets have been found associated with a number of ^3He -rich events

22-24 Apr 2020

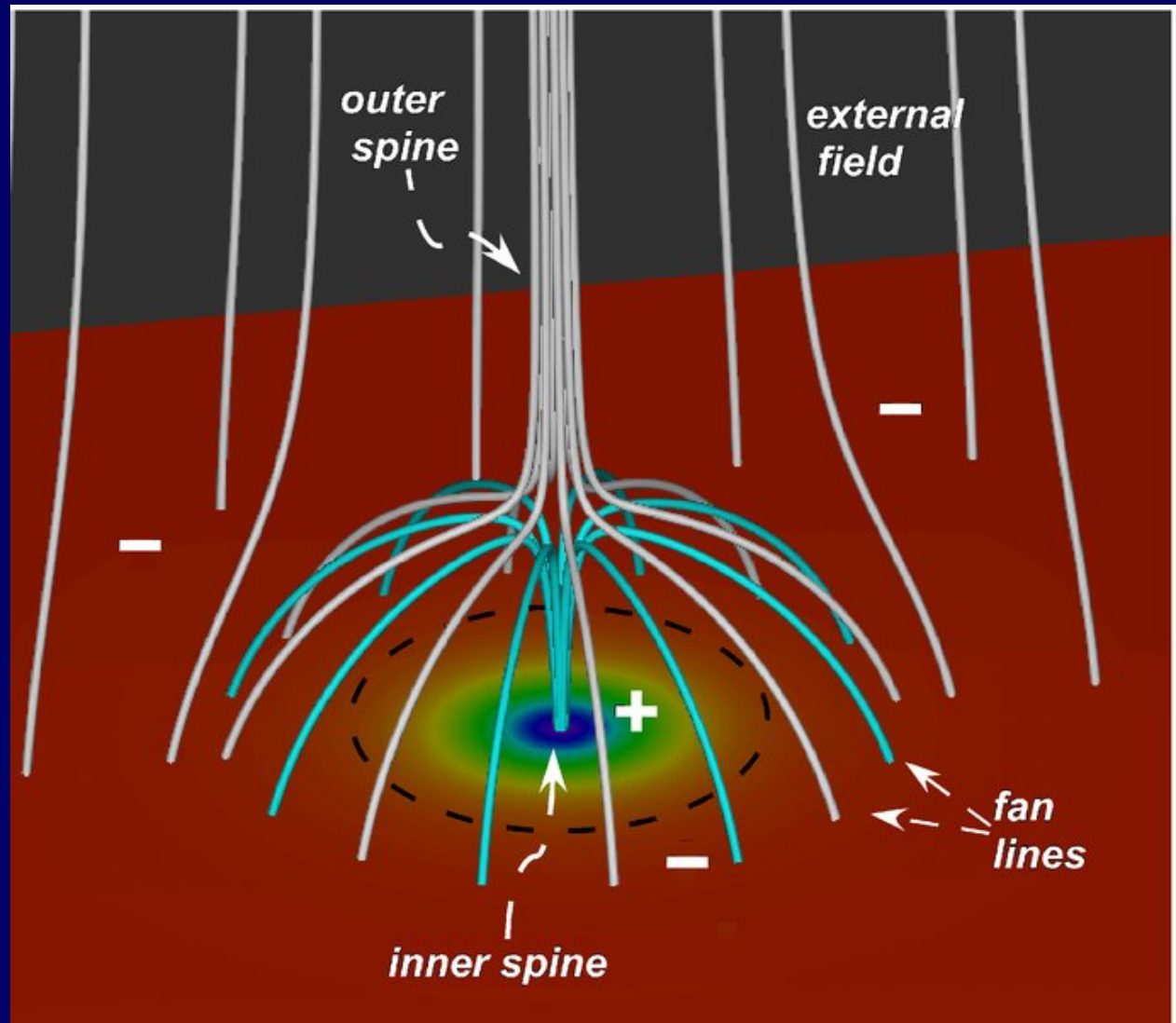


- Small events seen 20-21 Apr 2019
- PSP was at ~ 0.5 AU and well connected to both AR12738 and to Earth
- PSP detected ^3He energetic particles, which must come from coronal reconnection
- Implies that jet reconnection can accelerate particles
- Expect more observations as PSP approaches Sun



Magnetic Field of Coronal Jets

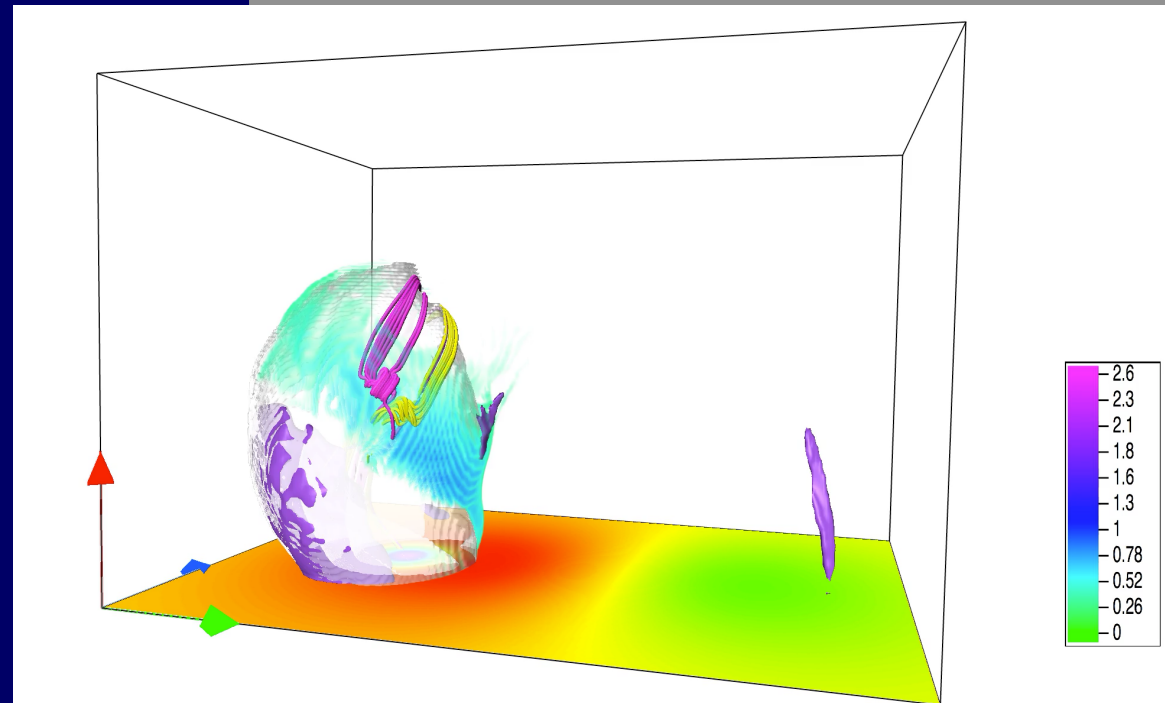
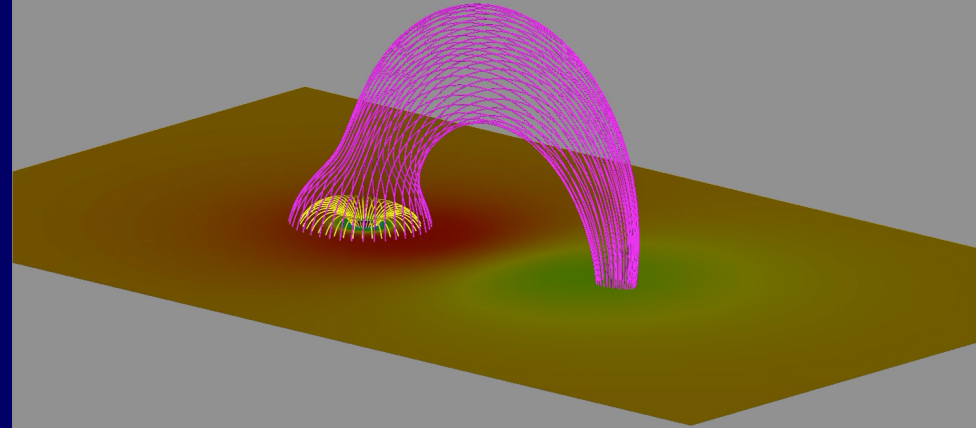
- Parasitic polarity in large-scale background field
 - Either open or closed
- Null point-fan-spines topology
 - Extremely common in corona
- Favorable for current sheet formation and reconnection



Jet Models

Pariat et al 2009, 2015; Wyper et al 2016, 2018

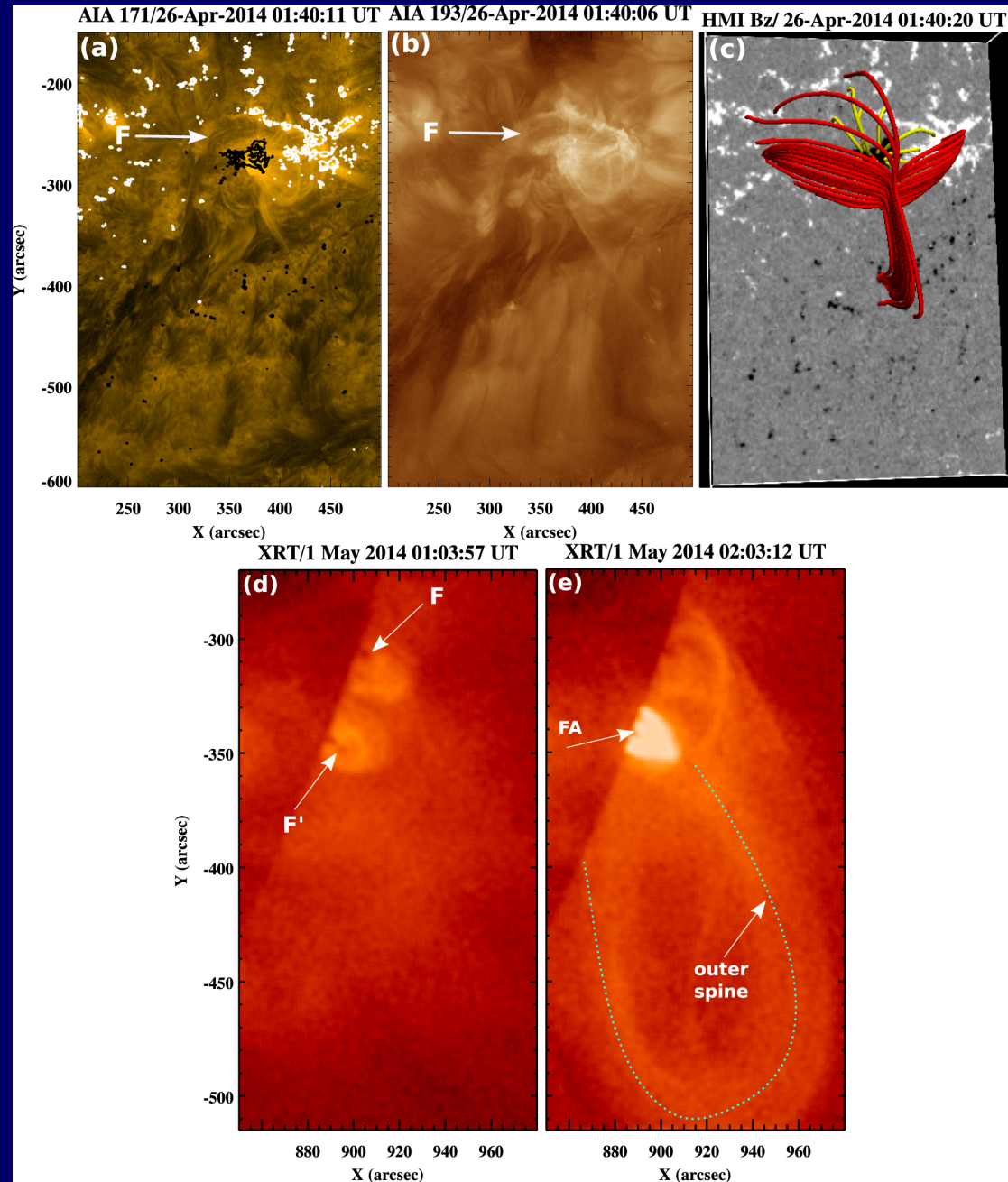
- Start with potential field and drive system by photospheric flows
 - generally rotational and concentrated at PIL
- Stress produces current sheet at null and separatrix
- Reconnection there similar to magnetopause reconnection
 - 3D flux ropes



Observations of Fast Helical Jet

Kumar et al 2019

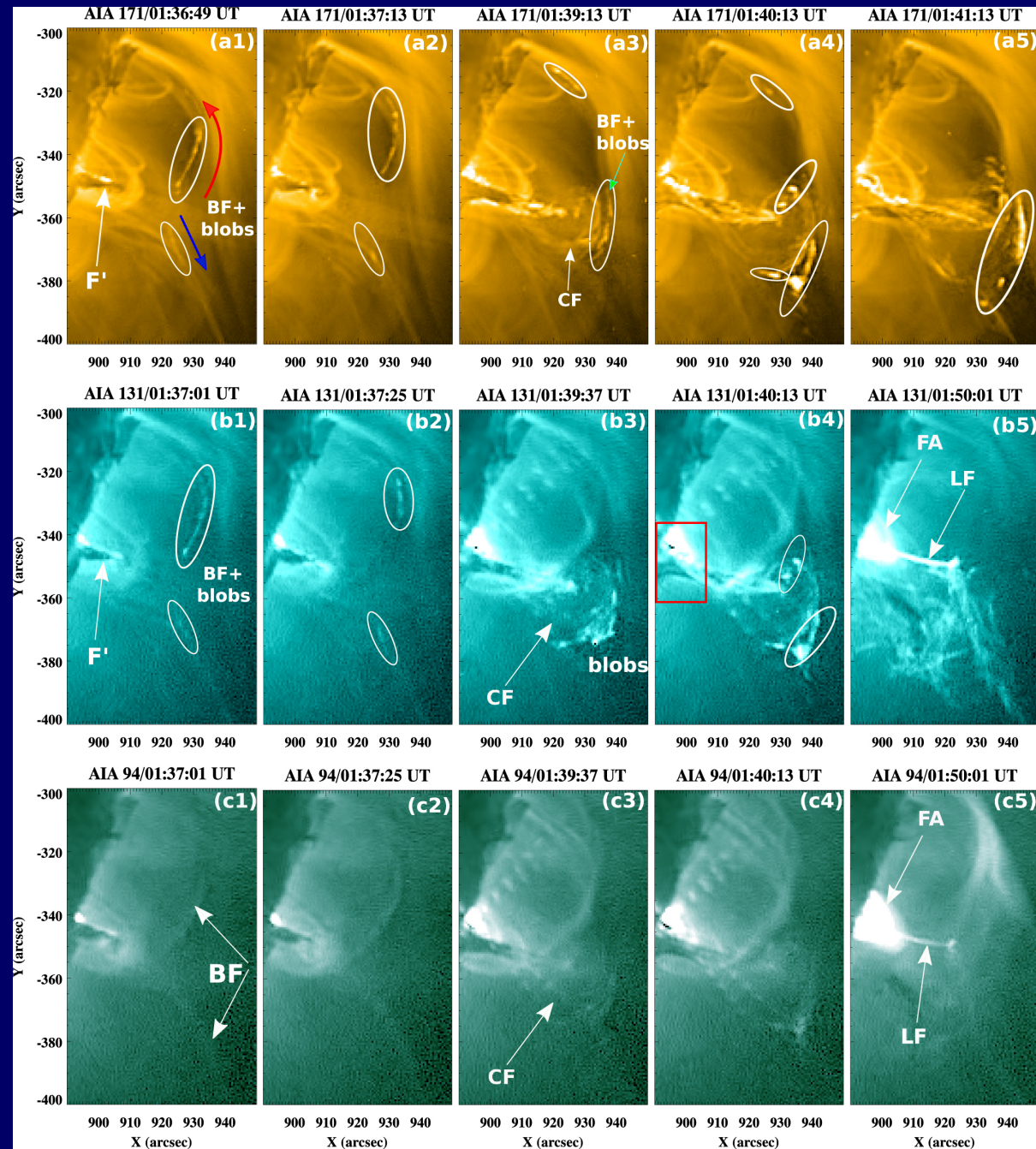
- Top: SDO AIA and HMI measurements of the photospheric magnetic field and coronal structure several days before the jet
- Topology identical to that of model
- Note presence of filament, so event essentially a confined flare
- Bottom: Hinode XRT X-Ray images before and after jet
- Outer spine remains closed
- Size scale of jet system $\sim 50,000$ km





- SDO/AIA movies of jet in different temperature bands 0.7 – 10 MK
- Running difference movie of jet in ~ 2 MK band
- IRIS movie of jet in $\sim .05$ and 10 MK

- See bi-directional flows and blobs (density enhancements) at fan surface and along outer spine
- Velocities range from 100 – 400 km/s and size scale of blobs $\sim 1,000$ km
- Clear evidence of reconnection outflows and 3D magnetic islands
- Have been seen before in flare current sheet/reconnection (similar to magnetotail), but never at null-point and fan surface
- May be effective at particle acceleration (PSP observations)



CONCLUSIONS

- Reconnection is primary mechanism driving explosive solar activity, such as jets and larger events, CMEs ...
- Two reconnection sites: one like magnetotail (flare current sheet) and one like magnetopause (breakout)
- Both show magnetic island formation and fast outflows, in both simulations and now observations
- Flare reconnection highly efficient particle accelerator, breakout seems less efficient, but also accelerator

FUTURE WORK

- High resolution simulations to determine scaling of islands with Lundquist number and 3D topology
- Kinetic modeling of breakout reconnection to determine dominant acceleration process(es)