Multi-angle observations of the base of recurrent solar jets

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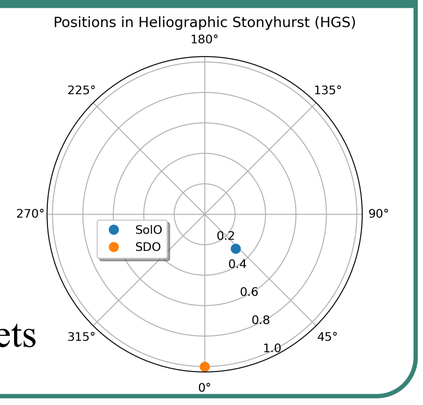
Motivation

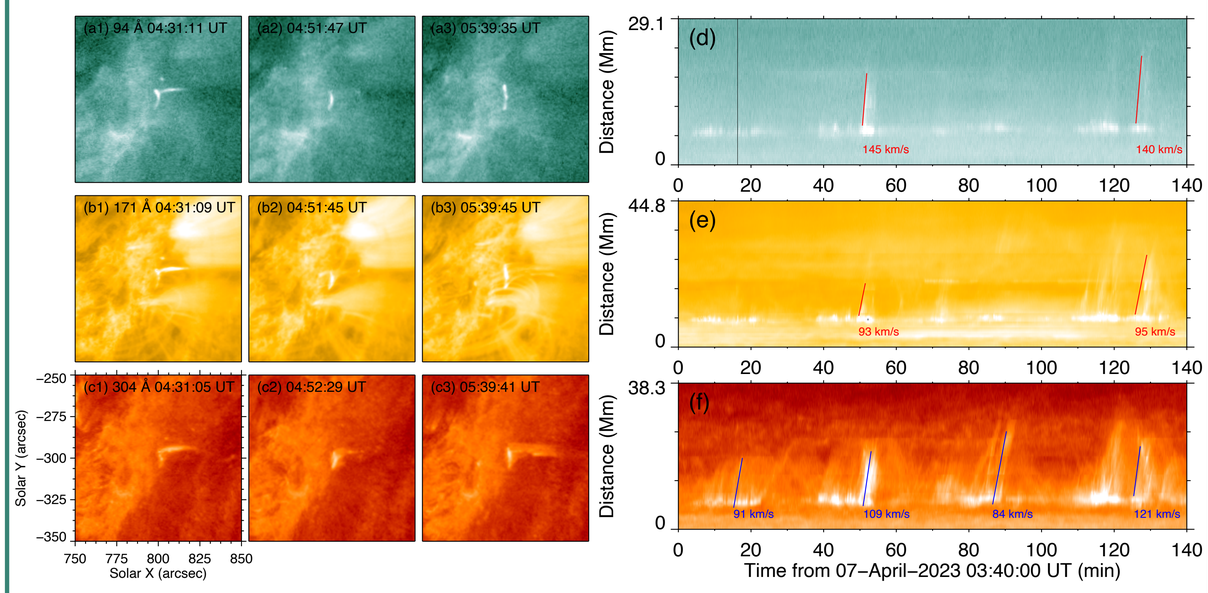
- Solar jets, characterized by small-scale plasma ejections along open magnetic field lines or the legs of large-scale coronal loops, play a crucial role in the dynamics of the solar atmosphere. They are often found to be associated with other solar activities, including campfires, filament eruptions, coronal bright points, flares, and coronal mass ejections.
- Although spectral and EUV images have been widely used in the analysis of the jet formation and evolution, there is still a lack of studies on the detailed three-dimensional (3D) structure and dynamics of the jet base due to the limit of the observation resolution.
- Solar Orbiter enables us to better investigate the structure of solar jets as it provides observations with much higher spatial and temporal resolutions and from a different angle.

Observation

- Date: 2023 April 7 03:00 - 07:00 UT
- SDO:
  AIA 0.″6 per pixel (~ 435 km) 12 s
- Solar Orbiter:
  EUI 0.″492 per pixel (~ 108.12 km) 3 s
  PHI 0.″5 per pixel (~ 109.88 km) 21 datasets

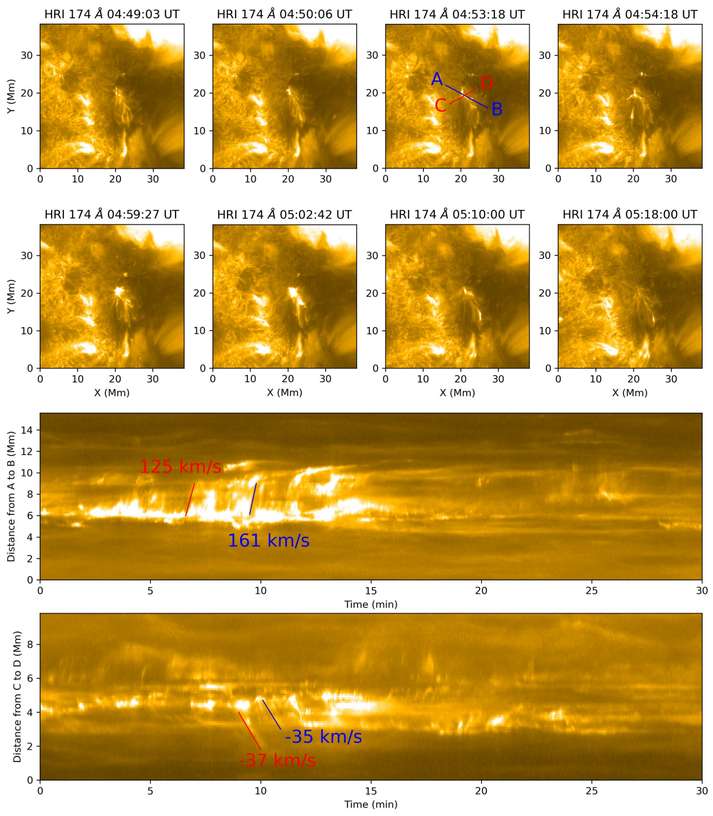


AIA observations of recurrent jets



- Four recurrent jets occur at the same region near the solar limb;
- These jets have a typical structure: bright base and a spire;
- Both hot (94 Å) and cool (304 Å) components could be observed;
- Hot jet spire component has a quicker speed than the cool component;
- Size ~ several Mm

EUI observations of the jet base



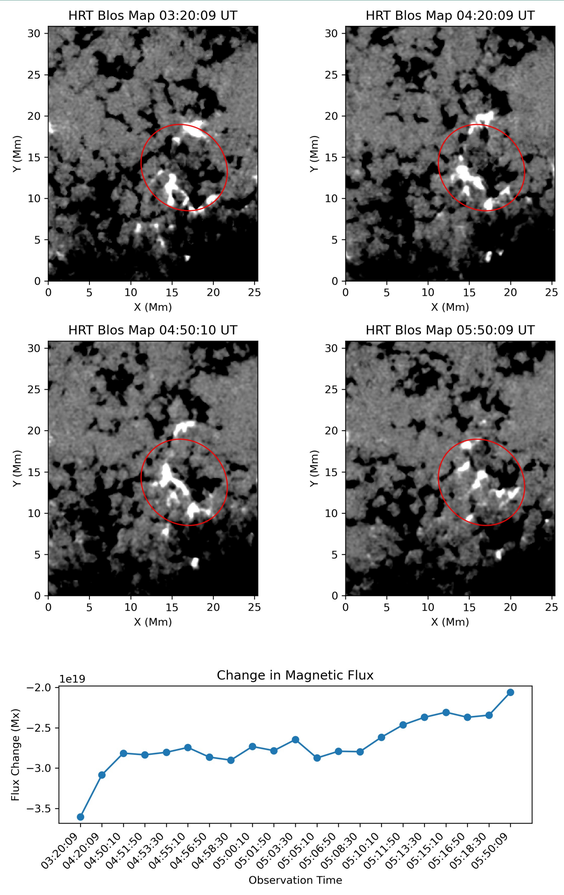
➢ Evolution of the jet base: (04:49-05:20 UT)

- discrete bright points
- merging and bifurcating
- evolving into an expansive bright region at peak time
- luminance diminishes, revealing a multi-pronged fan structure

➢ Bi-directional flows from the jet base: ~100 km/s

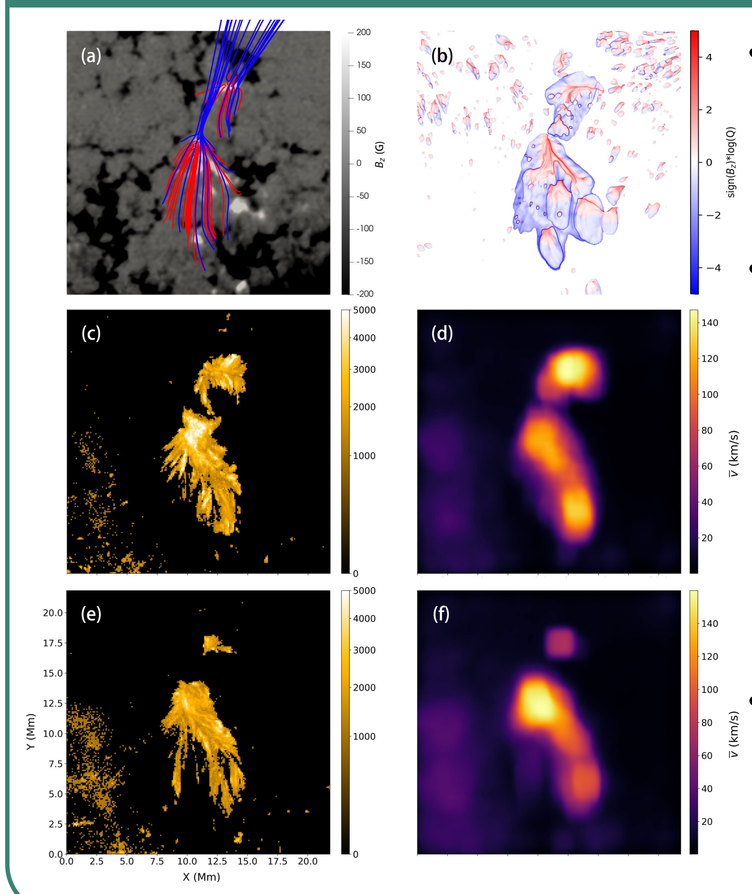
➢ Expansion : ~ 7 Mm

Magnetic flux change at the jet base



- Significant magnetic flux cancellation at the jet base region: positive magnetic flux moving towards the upper left, gradually diminishing and vanishing after canceling with surrounding negative magnetic flux.
- Magnetic flux inside the elliptical area decreasing with speed of:
  03:20-04:50 UT:
  8.8×10^{16} Mx/min
  04:50-05:20 UT
  1.6×10^{17} Mx/min
  05:20-05:50 UT
  8.9×10^{16} Mx/min

Magnetic structure of the jet base



- (a) and (b) are the fan-spine structure and QSL map from the potential field extrapolation.
- The flow overlay map of the second jet in (c) and the third jet in (e) aligns closely with the fan structure and the QSL: the flow at the jet base is confined within the fan structure.
- Average velocity distribution in (d) and (f): the flow speed near the null-point is the highest.

Conclusion

➢ The recurrent jets near the solar limb are driven by magnetic flux cancellation and reconnection, with flows at the base confined within the fan structure and highest velocities near the null-point. The evolution of the jet base and its velocity distribution highlight the critical role of magnetic reconnection in shaping the jet dynamics.