ON THE OBSERVATION AND SIMULATION OF SOLAR CORONAL TWIN JETS

Jiajia Liu[1,3], Fang Fang[2], Yuming Wang[1,5], Scott W. McIntosh[4], Yuhong Fan[4], Quanhao Zhang[1,3]

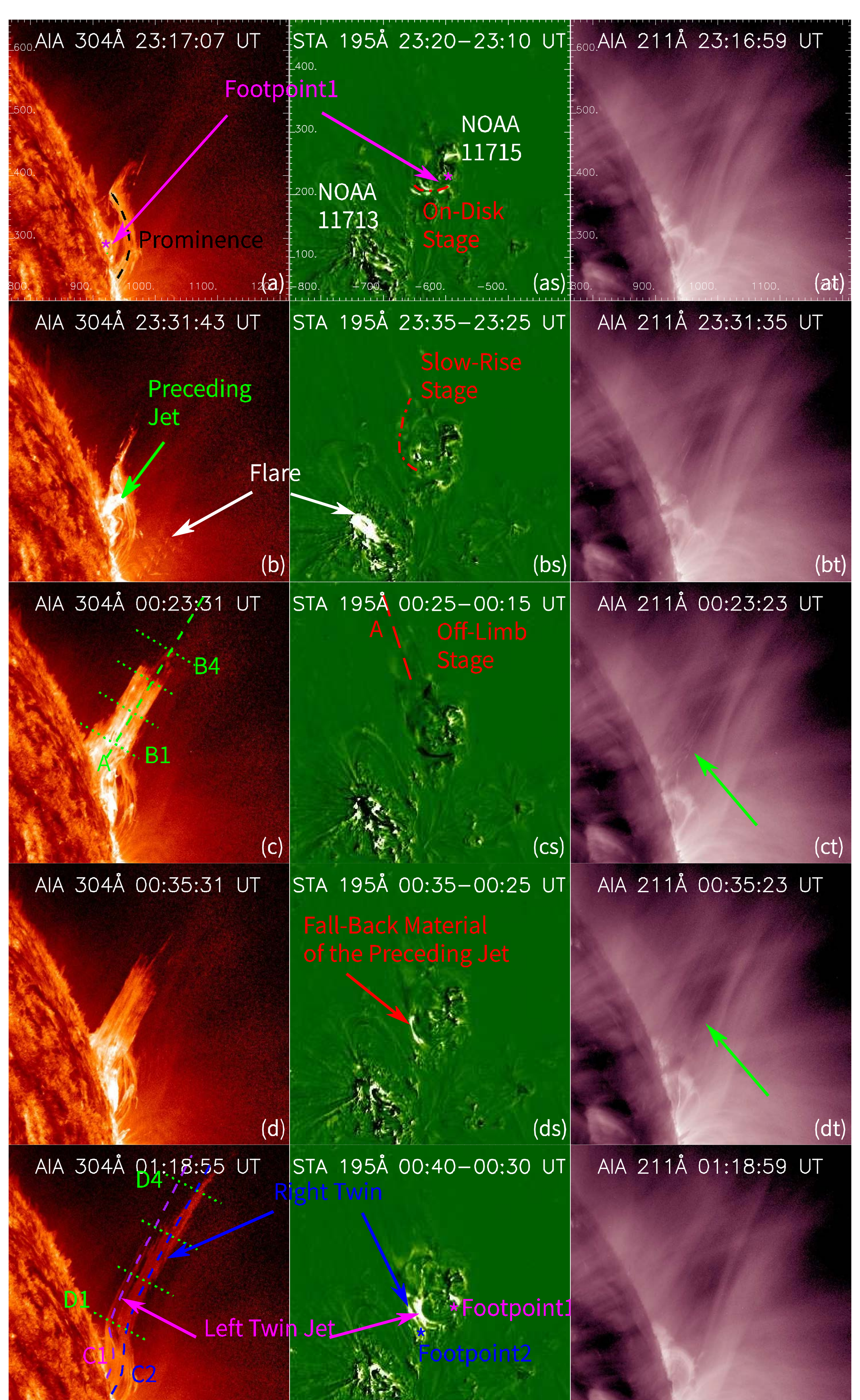
1. School of Earth and Space Sciences, University of Science & Technology of China, Hefei 230026, China; 2. Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder, Boulder, CO 80303, US; 3. Collaborative Innovation Center of Astronautical Science and Technology, Hefei 230026, China; 4. High Altitude Observatory, National Center for Atmospheric Research, Boulder, CO 80307, US; 5. Synergetic Innovation Center of Quantum Information & Quantum Physics, University of Science & Technology of China, Hefei, Anhui 230016, China

I. INTRODUCTION

- Reconnection plays crucial role in triggering solar jets. Twists propagates in open field lines after reconnection and the untwisting process causes the rotational motion of jets. The untwisting process is a manifestation of further magnetic field relaxation after reconnection. **The further relaxation of magnetic field is thought to support the climb of jets after reconnection and injects more of the jet's kinetic energy than reconnection does during a typical EUV jet event [*Liu et al. 2014*].**

- Further releasing of magnetic free energy may take place in terms of recurring jets. When persistent flow continuously injects energy into the corona from the sub-surface regions, recurring jets may present. **However, in this poster we present the observation and analysis on another possibility – solar coronal twin jets after a preceding blowout jet. We combine observational data and 3D MHD simulation [*Fang et al. 2014*] to demonstrate that the twin jets are generated via the reconnection between ambient open fields with a highly twisted sigmoidal magnetic flux which is the outcome of the evolution of the magnetic field configuration during the preceding jet.**

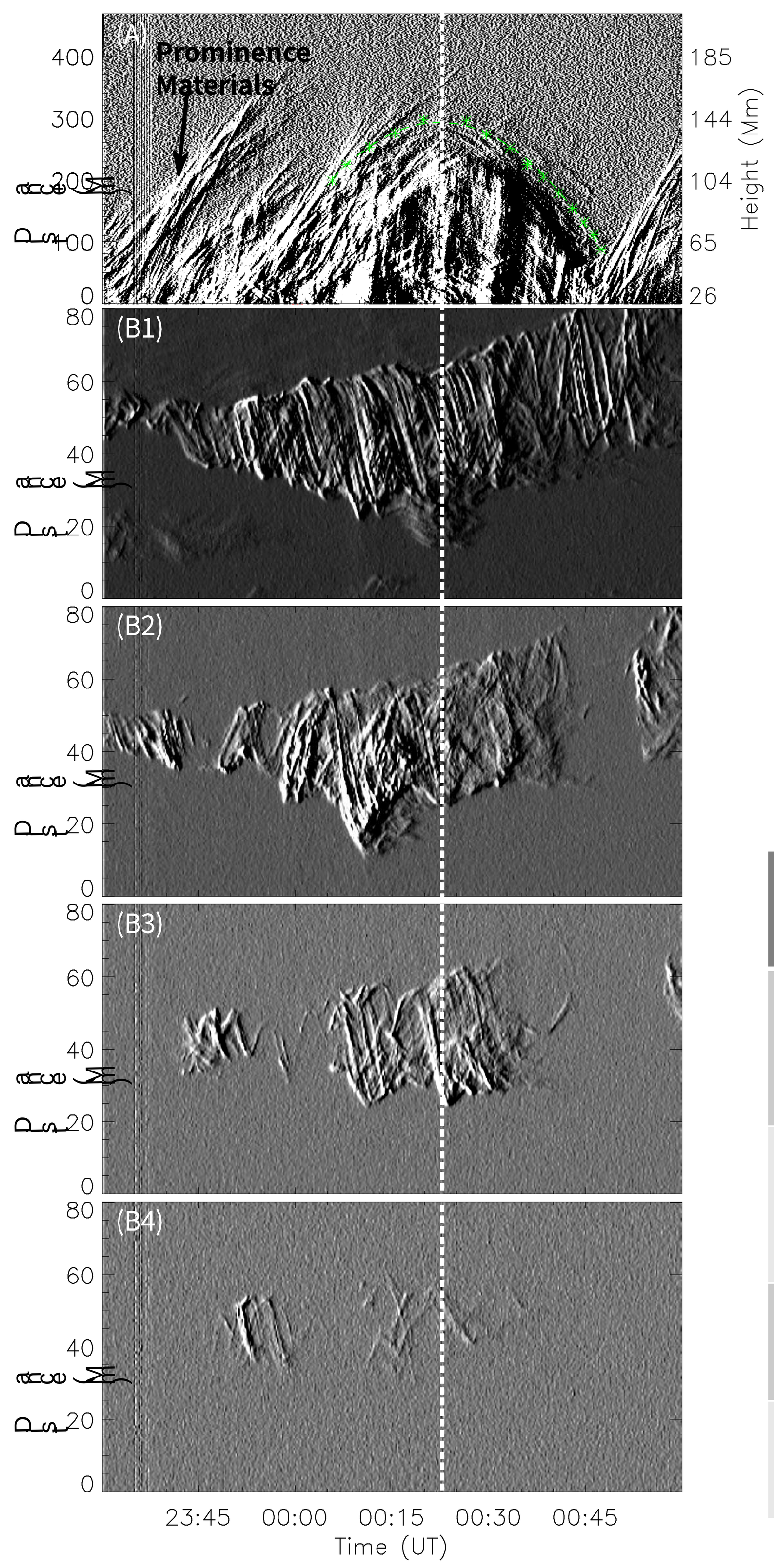
II. OVERVIEW

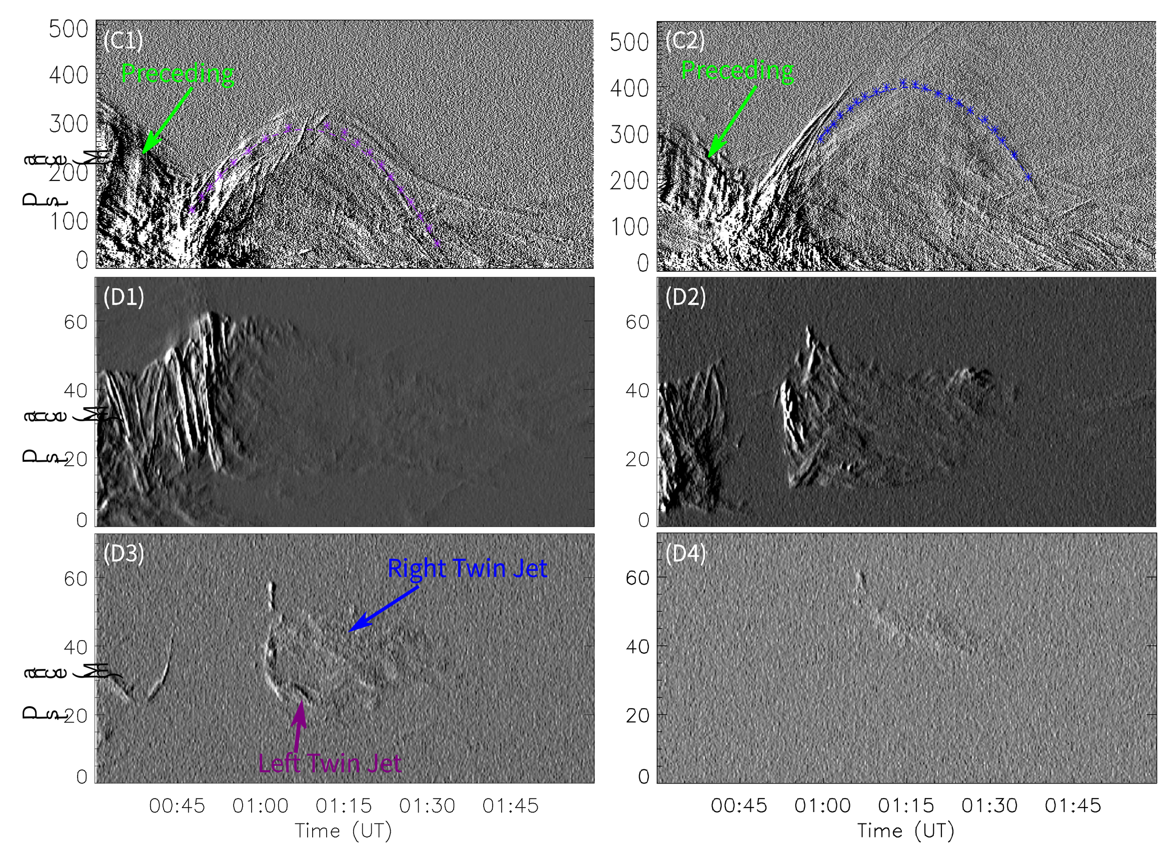


The first jet ("preceding jet") originated from "Footpoint1" around 23:17 UT April 10th 2013. It traveled on-disk until 23:20 UT and then arose slowly before 23:32 UT. After that, it began to ascend straightly off the limb and reached its maximum height at around 00:23 UT April 11th. Continuous rotational motion of threads around the jet's axis can be observed during its whole off-limb stage.

Around the end of the off-limb stage of the preceding jet, another two jets erupted. They are called "twin jets" as they were simultaneously triggered with close footpoints and they stayed very close together and shared plenty of commonalities in temperature, brightness and kinetic properties. The twins are smaller in size and didn't show obvious rotational motion during their off-limb stage.

III. KINETICS

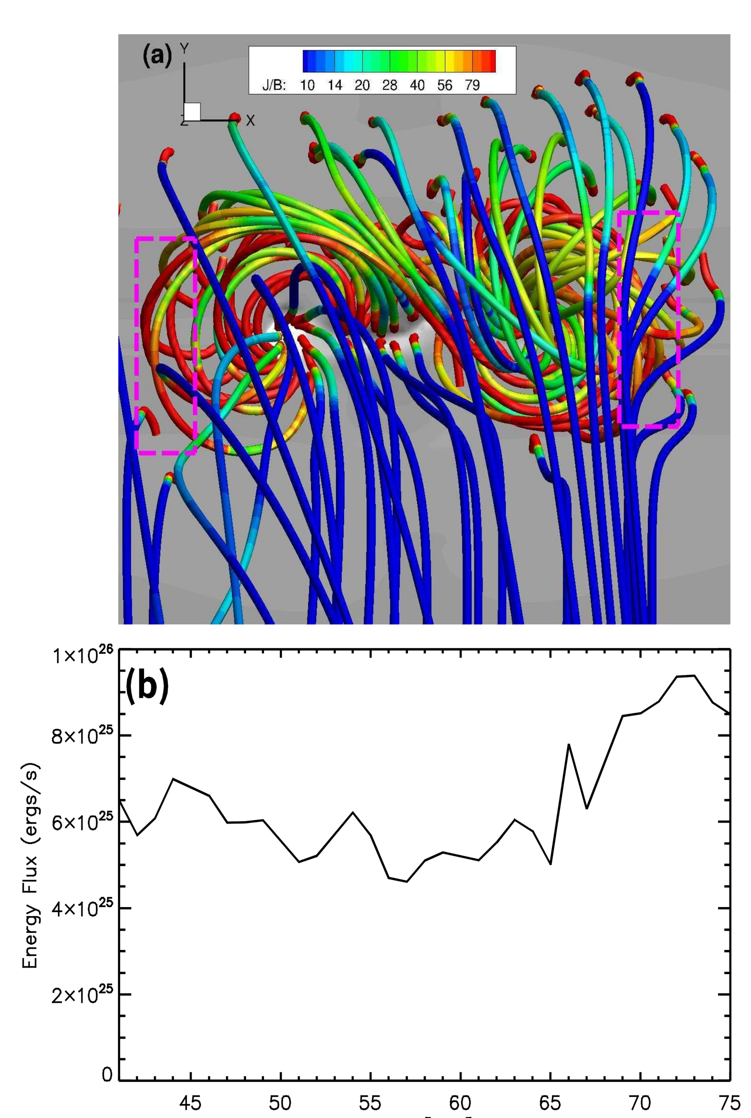


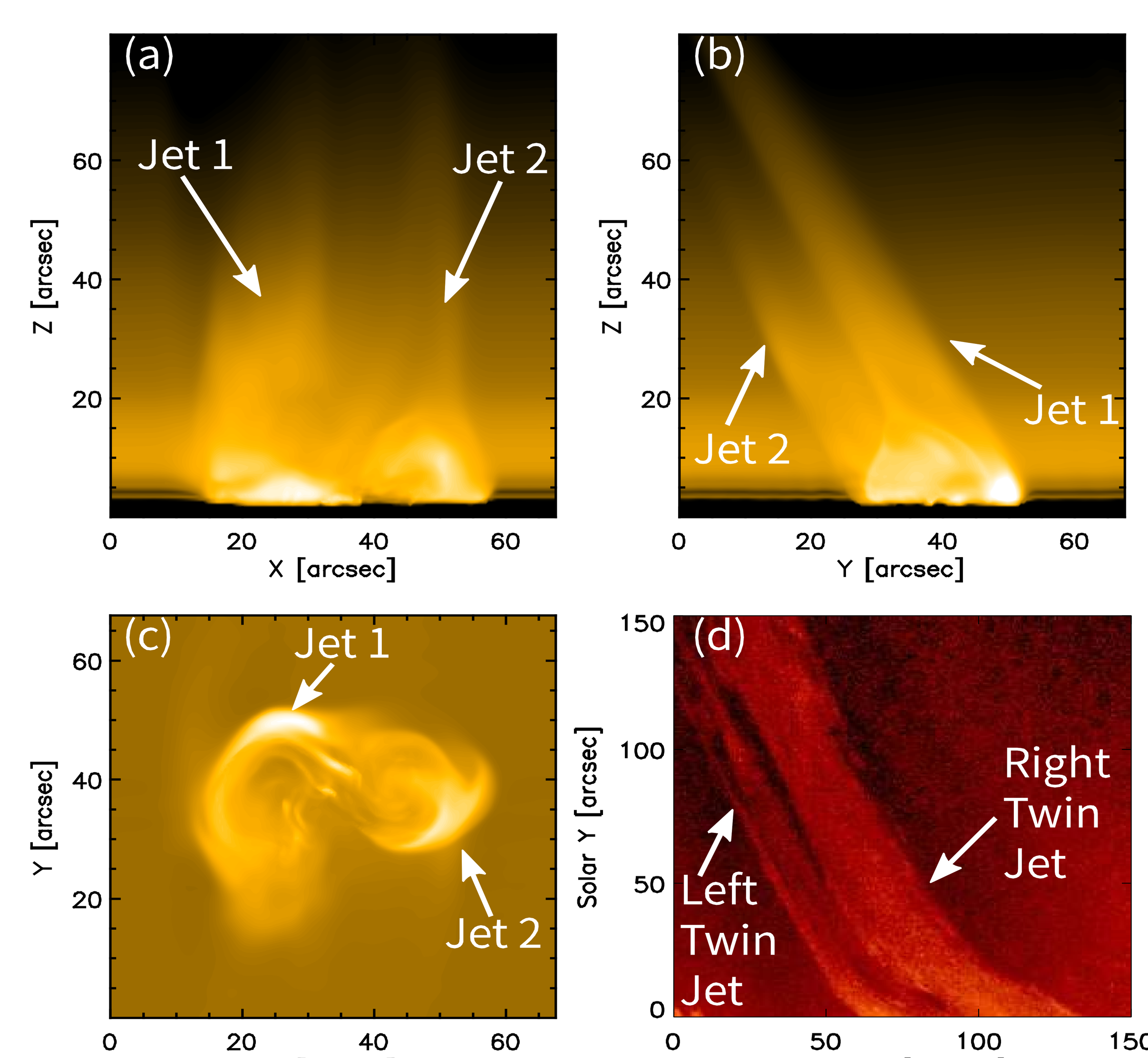


	Preceding Jet	Left Twin	Right Twin
Brightening before eruption	√	×	×
Accelerating at early stage	√	×	×
Deceleration (m/s^2)	-182±10	-229±8	-234±11
Rotating Period (s)	569±91	×	×

Average local gravity is about $-220\ m/s^2$.

IV. NUMERICAL SIMULATION





V. SUMMARY

- The preceding jet underwent an acceleration during its on-disk, slow-rise and early off-limb stages. Continuous rotational motion of the jet's material around its axis could also be observed during the whole off-limb stage. Sine-function fit shows that the rotational motion kept almost the same period of about 569±91 s at different height and did not changed much with time. **Observational features suggest its blowout-jet nature.**

- Significantly different from the preceding blowout jet, without apparent underneath activities before their initiations, the twin jets were triggered around the end of the off-limb stage of the preceding one. They were shot out with pretty high axial speeds but rare rotational motions.

- Using 3D MHD numerical simulation, **we find that a pair of twin jets form due to reconnection between the ambient open fields and a highly twisted sigmoidal magnetic flux which is the outcome of the further evolution of the magnetic fields during the preceding blowout jet.**

- Precise estimation on the energy budget is still needed.

- the sigmoidal structure, which was a remarkable signature during the twin jets event according to the simulation, was not observed directly in this paper probably due to the relatively low cadence and resolution of the STEREO/EUVI instruments and/or different temperatures.

- We continue the 3D MHD numerical simulation in *Fang et al. 2014*. A stationary central-buoyant twisted magnetic flux rope is initially imposed in the convection zone just underneath the photosphere.
- The emerging fields in the outer periphery of the flux rope reconnect first with the ambient open fields, producing a standard jet. Further reconnection opens up the confining field and releases the twisted core into the corona. **Reconnection that involves the core field drives a violent eruption which is observed as the preceding blowout jet.**

- During the preceding blowout jet, sigmoidal current sheet forms in the emerging flux rope, together with the inverse-S shaped magnetic field configuration. The distribution of current density |J|/|B| represented by the color of the rods clearly shows that the sigmoidal magnetic fields are loaded with strong current in the two ends outlined by the two dashed rectangles.
- The direction of the sigmoidal fields are aligned in the +Y direction in the dashed rectangles at the two ends of the sigmoid, which are anti-parallel to the ambient fields in the –Y direction. The configuration of magnetic fields and the current in these two regions give rise to reconnection between the sigmoidal and ambient fields at the two ends.
- **Reconnection at these two regions drives mass outflow along the field lines at the two arms of the sigmoidal structure forming the twin jets.**