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Successive Two-sided Loop Jets Caused by Magnetic Reconnection between Two Adjacent Filamentary Threads

Zhanjun Tian[1,2,3], Yu Liu[1,4,5], Yuandeng Shen[1,2,4,5,6], Abouazza Elmhamdi[7], Jiangtao Su[3,4,6], Ying D. Liu[2,3], and Ayman. S. Kordi[7]

[1] Yunnan Observatories, Chinese Academy of Sciences, Kunming, 650216, China; ydshen@ynao.ac.cn
[2] State Key Laboratory of Space Weather, Chinese Academy of Sciences, Beijing 100190, China
[3] University of Chinese Academy of Sciences, Beijing 100049, China
[4] Center for Astronomical Mega-Science, Chinese Academy of Sciences, Beijing, 100012, China
[5] Key Laboratory of Geospace Environment, Chinese Academy of Sciences, University of Science & Technology of China, Hefei 230026, China
[6] Key Laboratory of Solar Activity, National Astronomical Observatories, Chinese Academy of Science, Beijing 100012, China
[7] Department of Physics and Astronomy, King Saud University, P.O. Box 2455, 11451, Saudi Arabia
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Abstract

We present observational analysis of two successive two-sided loop jets observed by the ground-based New Vacuum Solar Telescope and the space-borne *Solar Dynamics Observatory*. The two successive two-sided loop jets manifested similar evolution processes and both were associated with the interaction of two small-scale adjacent filamentary threads, magnetic emerging, and cancellation processes at the jet's source region. High temporal and high spatial resolution observations reveal that the two adjacent ends of the two filamentary threads are rooted in opposite magnetic polarities within the source region. The two threads approached each other, and then an obvious brightening patch is observed at the interaction position. Subsequently, a pair of hot plasma ejections are observed heading in opposite directions along the paths of the two filamentary threads at a typical speed for two-sided loop jets of the order 150 km s^{-1}. Close to the end of the second jet, we report the formation of a bright hot loop structure at the source region, which suggests the formation of new loops during the interaction. Based on the observational results, we propose that the observed two-sided loop jets are caused by magnetic reconnection between the two adjacent filamentary threads, largely different from the previous scenario that a two-sided loop jet is generated by magnetic reconnection between an emerging bipole and the overlying horizontal magnetic fields.

Key words: Sun: activity – Sun: filaments, prominences – Sun: flares – Sun: magnetic fields

Supporting material: animations

1. Introduction

Coronal jets are collimated hot plasma flows along open magnetic field lines. They were originally discovered in the 1980s and then intensively studied in the 1990s, thanks to the unprecedented X-ray observations by the *Yohkoh* (Ogawara et al. 1991) satellite (e.g., Shibata et al. 1992, 1994a; Shimojo et al. 1996, 1998; Innes et al. 1997). Subsequently, substantial improvements in the observations made using space telescopes such as *Hinode* (Kosugi et al. 2007), *Solar TErrestrial RElations Observatory* (*STEREO*; Kaiser et al. 2008), *Solar Dynamics Observatory* (*SDO*; Pesnell et al. 2012), and *Interface Region Imaging Spectrograph* (*IRIS*; de Pontieu et al. 2014) have helped solar physicists make important findings and improve their understanding of both the observational and theoretical research aspects of coronal jets (see the recent reviews by e.g., Tsiropoula et al. 2012; Raouafi et al. 2016, and references therein). As coronal jets or jet-like phenomena such as spicules, surges, and sprays are ubiquitous in the solar atmosphere and always associated with magnetic reconnection process, they are considered to be a possible source for solving the enigmatic problems of coronal heating and acceleration of the fast solar wind (e.g., Innes et al. 1997; Shibata et al. 2007; Tian et al. 2014; Martínez-Sykora et al. 2017). Despite advances in recent years that have enriched our understanding of the different physical and observational processes and numerical investigations behind solar coronal jets, there are still many unsolved problems, especially concerning their driving and evolution mechanisms.

It has been widely accepted that coronal jets are formed due to the reconnection of emerging magnetic fluxes with ambient magnetic fields (e.g., Shibata et al. 1994b; Zhang et al. 2000; Liu & Kurokawa 2004; Jiang et al. 2007; Yang et al. 2011; Li et al. 2012, 2015, 2017a, 2017b; Shen et al. 2014). Sometimes magnetic flux cancellation in the source region is also important for producing coronal jets (e.g., Chen et al. 2009, 2015, 2017; Hong et al. 2011, 2014, 2017; Shen et al. 2012; Adams et al. 2014; Zhang & Ji 2014a, 2014b; Li et al. 2015; Ni et al. 2015, 2017; Panesar et al. 2016). In addition, some authors believe that coronal jets can be launched by the mechanism of chromospheric evaporation (e.g., Shimojo et al. 2001; Miyagoshi & Yokoyama 2003). Shibata et al. (1994a) suggested that coronal jets can be divided into two types according to their morphology, namely, the so-called "anenome" jet and the "two-sided loop" jet. The former appear to occur frequently in or near active regions, while the latter often take place in quiet-Sun regions. Anenome jets are formed due to the reconnection between emerging bipoles and the vertical or oblique ambient magnetic fields. Eventually, the upward and downward hot plasma flows from the reconnection site form the observed jet and the brightening at the jet base, respectively. The two-sided loop jets are thought to be produced by the reconnection of emerging bipoles with the pre-existing horizontal magnetic field lines, while the hot