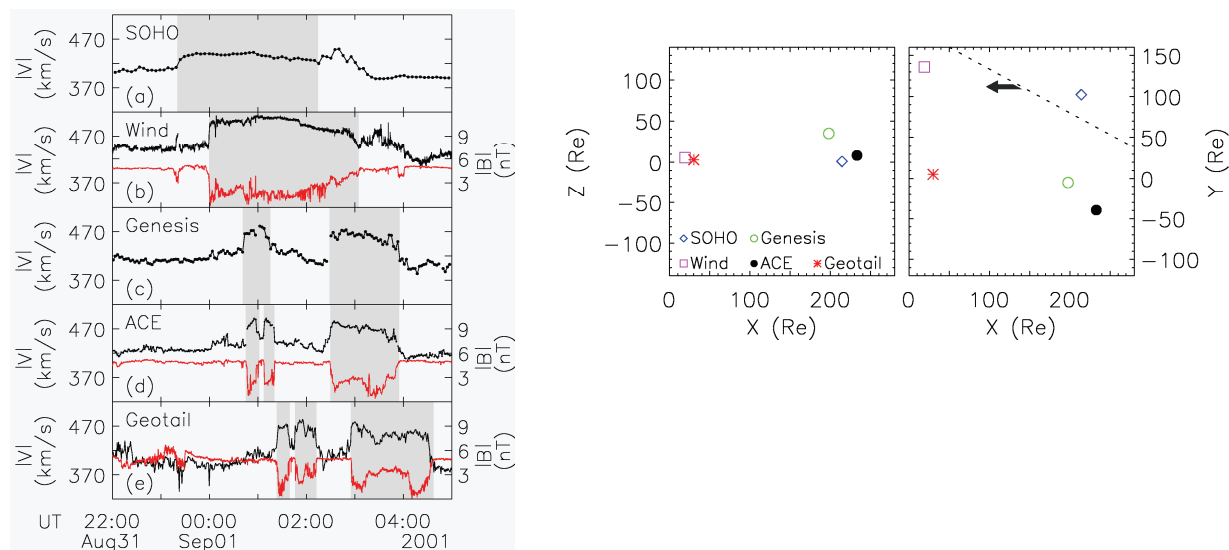


Prolonged Reconnection at an Extended and Continuous X-line in the Solar Wind



Magnetic reconnection is commonly invoked to explain a variety of space, solar, astrophysical and laboratory plasma phenomena. It has long been debated whether reconnection is fundamentally patchy in space and time or if, instead, it can occur in a quasi-stationary manner over an extended region in space. Direct evidence that reconnection commonly occurs in the solar wind is found in ACE observations of jetting Alfvénic plasma flows confined to magnetic field reversal regions. Multi-spacecraft measurements of such jetting plasma flows, known as reconnection exhausts, have suggested that they originate from quasi-stationary reconnection at extended reconnection sites (X-lines) in the solar wind. However, in events studied thus far one cannot conclusively rule out the possibility that reconnection was actually patchy in both space and time since in events studied to date each spacecraft typically encountered an exhaust for only a few minutes and sampled only a limited extent of the X-line.

The figure on the left above shows the solar wind speed (black) measured by ACE and four other spacecraft (SOHO, Wind, Genesis, and Geotail), all upstream from Earth in the solar wind, during a 7-hour interval on 31 August and 1 September 2001. Measurements of the magnetic field strength by ACE, Wind and Geotail are shown in red. The figure on the right shows the relative positions of the different spacecraft in GSE coordinates at the time of these observations. (In the GSE system the X-axis points from Earth to the Sun, the Y-axis is in the ecliptic plane pointing opposite the Earth’s direction of motion, and the Z-axis is parallel to the ecliptic pole). In order, SOHO, Wind, Genesis, ACE and Geotail observed a ~3-hour-long interval of accelerated flow, indicated by shading in the figure. SOHO and Wind (both at relatively large +Y separations from the Sun-Earth line) observed uninterrupted speed enhancements, whereas the other 3 spacecraft (all in the vicinity of the Sun-Earth line) observed speed enhancements that were interrupted by intervals of varying duration wherein the speed (and field strength) returned to pre-existing solar wind levels. This exceptionally long event occurred within the field reversal region associated with a crossing of the heliospheric current sheet. The dashed line in the right figure indicates the inferred intersection of the exhaust plane with the GSE XY plane. The combined measurements reveal that 1) the exhaust extended at least 3.4×10^6 km in the direction of the X-line, 2) the leading exhaust boundary was non-planar; and 3) reconnection persisted for at least 5 hours along a continuous X-line. These observations thus provide the most conclusive evidence to date for prolonged reconnection along an extended and continuous X-line in a space plasma. For additional information, see Gosling et al., *Geophys. Res. Lett.*, 34, L06102, 2007.

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