Multiple magnetic topologies in flux transfer events at the magnetopause: THEMIS measurements

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Flux transfer events (FTEs) are local transient magnetic reconnections at the magnetopause (MP) that provide channels for transport of solar wind energy and plasma into the magnetosphere (MSP). All current theoretical models suggest that FTEs are open-flux ropes; however, 3D and global simulations show that they contain both open and closed magnetic fields. To clarify this topology, we analyzed 441 events measured by THEMIS from 2009 to 2011 for which the electron energy-pitch angle distribution was successfully detected. Only open field lines were detected in most magnetosheath (MSH) FTEs, either MSH→ northern MSP or Southern MSP→MSH, independent of the polarity of the B_n bipolar signatures. Newly formed MSH field lines might also be observed. In all MP current layers FTEs and most MSP FTEs, multiple types of topologies were observed, irrelevant to the B_n bipolar polarity. Closed field lines were found in all MP current layer and MSP FTEs. Meanwhile very few current layer FTEs contained the newly formed MSH flux. In some situations, only closed field lines were seen in MSP FTEs, which are referred to as the fossil FTEs.

These results are largely different from the traditional views, demonstrating the existence of complex magnetic topologies in FTEs. Based on these results, we propose a new 3D FTE picture to modify the current FTE models. Mechanisms that produce the FTEs and their multiple magnetic topologies are discussed.