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Three-dimensional magnetic flux rope structure formed by multiple sequential X-line reconnection at the magnetopause

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It is widely accepted that the magnetic flux transfer events (FTEs) form a channel between the magnetosphere and magnetosheath to allow transport of solar wind plasma and energy into geospace. On June 14, 2007 four THEMIS spacecraft observed a FTE on the dayside magnetopause which has been previously interpreted as a reconnected flux rope, generated by a double X-line in a two-dimensional (2D) context. This presentation reports a further study of the event to show the three-dimensional (3D) viewpoint based on additional measurements and to confirm that multiple, sequential X-line reconnection (MSXR) is operating. The 3D structure of the FTE flux rope across the magnetospheric boundary is obtained on the basis of multi-point measurements taken on both sides of the magnetopause. The flux rope's azimuthally extended part (leading to the magnetosheath branch of the reconnected flux) is found to lie approximately on the magnetopause surface and parallel to the X-line direction; whilst the axis of the magnetospheric branch is essentially along the local unperturbed magnetospheric field lines. In the central region of the flux rope, as distinct from the traditional viewpoint, we find from the electron distributions that two types of magnetic field topology co-exist: opened magnetic field lines connecting the magnetosphere to the magnetosheath and closed field lines connecting the southern and northern hemispheres. We confirm, therefore, for the first time in-situ, the characteristic feature of the 3D reconnected magnetic flux rope, formed through MSXR, through a determination of the field topology and the plasma distributions within the flux rope. Knowledge of the complex geometry of FTE flux ropes will improve our understanding of solar wind-magnetosphere interaction.