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Interactions between dipolarization front and magnetic reconnection: MMS observations

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Magnetic reconnection, releasing magnetic energy and energizing plasmas, are believed to be responsible for the explosive phenomena in space.[1] Magnetic reconnection can also lead to the generation of magnetic structures, such as flux ropes and dipolarization fronts (DFs). Observations and simulations have proved that flux ropes can coalesce with each other through reconnection, and reconnection can also occur inside flux ropes.[2, 3] Then, it is reasonable to ask whether DFs have similar processes as flux ropes. However, the interactions between the dipolarization front and magnetic reconnection are rarely investigated.

Using the data from the Magnetospheric Multiscale (MMS) mission, two events in the magnetotail are presented. In the first event, direct evidence of magnetic reconnection at a dipolarization front is found, and the reconnection leads to strong energy conversion at the dipolarization front. In the second event, an electron-only reconnection current sheet is found between two successive dipolarization fronts, which may coalesce by the reconnection. Our observations show that dipolarization fronts have complex interactions with magnetic reconnection rather than only a carrier of the energy and magnetic flux released by reconnection.

References

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[2] R. S. Wang *et al*, Nat. Phys., **12**, 263 (2016)
[3] S. M. Wang *et al*, Nat. Commun., **11**, 3964 (2020)

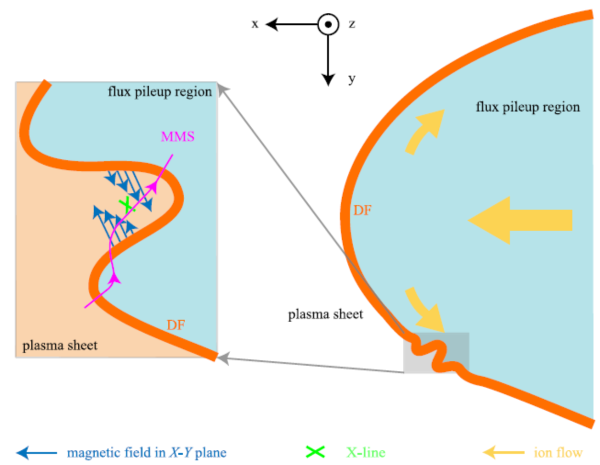

Figure 1. A sketch of MMS's crossing of the bent DF. The yellow arrows stand for the ion flows. The blue arrows denote the magnetic field in the X-Y plane. The green cross represents the X-line. The magenta line is the trajectory of MMS.

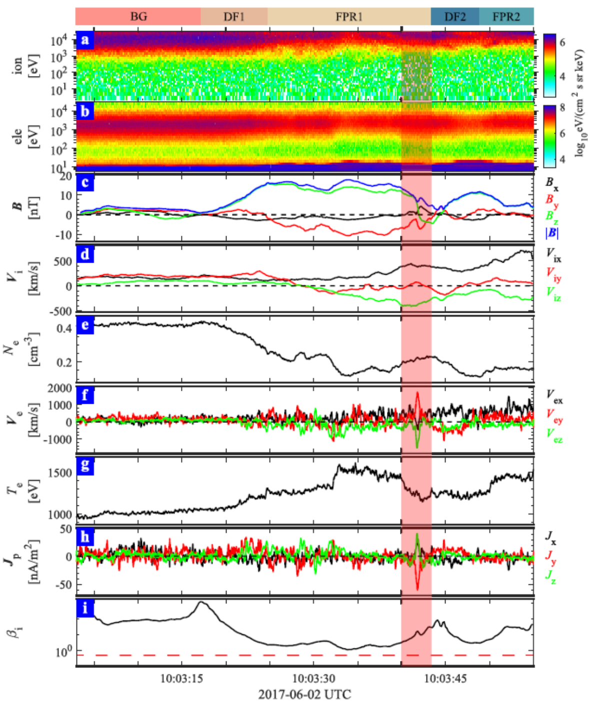

Figure 2. MMS2's observations of dipolarization fronts (DFs) in the terrestrial magnetotail. (a) Ion and (b) electron omnidirectional differential flux; (c) magnetic field; (d) ion velocity; (e) electron density; (f) electron velocity; (g) electron temperature; (h) current density calculated by plasma moments $\boldsymbol{J} = ne(\boldsymbol{V}_i - \boldsymbol{V}_e)$; (i) plasma beta, the red dashed line is 0.5. The bars on the top mark different parts, in which "BG" stands for the background plasmas, "DF1" stands for the first dipolarization front, "FPR1" stands for the flux pileup region of the first dipolarization front, "DF2" stands for the second dipolarization front, and "FPR2" stands for the flux pileup region of the second dipolarization front. The red shade stands for the current sheet. All data are from MMS2 and presented in geocentric solar magnetospheric coordinates.