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On the Magnetic Dip Ahead of the Dipolarization Front

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In the Earth's magnetotail, dipolarization front (DF) is a commonly observed structure and plays crucial roles in magnetic flux and plasmas transport. It is widely considered as a result of magnetic reconnection[1].

The most common characteristic of the DF is the sharp enhancement of the northward magnetic field B_z. Statistical studies[2] indicated that the DF sometimes is preceded by a small decrease in B_z, which is capable of trapping and accelerating particles. However, the formation mechanism of the B_z dip is not well known.

In this study, we aim to investigate the formation of the B_z dip ahead of the DF with Magnetospheric MultiScale (MMS) satellite observations and particle-in-cell techniques. We first presented two DF events with and without a dip, as shown in Figure 1. By comparing these two events, the B_y field is deemed to be the determining factor in forming the dip.

Then we conducted kinetic simulations of symmetric magnetic reconnection under various guide fields[3]. Our results show that the magnetic field dip is formed only when a guide field is strong enough to separate ion dynamics and electron dynamics. The guide field deviates more ions further away from the central plane than electrons. The remaining electrons near the DF thus carry a current that is responsible for the magnetic field dip. Our simulation results can well explain the observed DF events that the magnetic dip is indeed present when accompanied with a non-negligible guide field and thus bring in a new perspective on the formation of the dip.

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References

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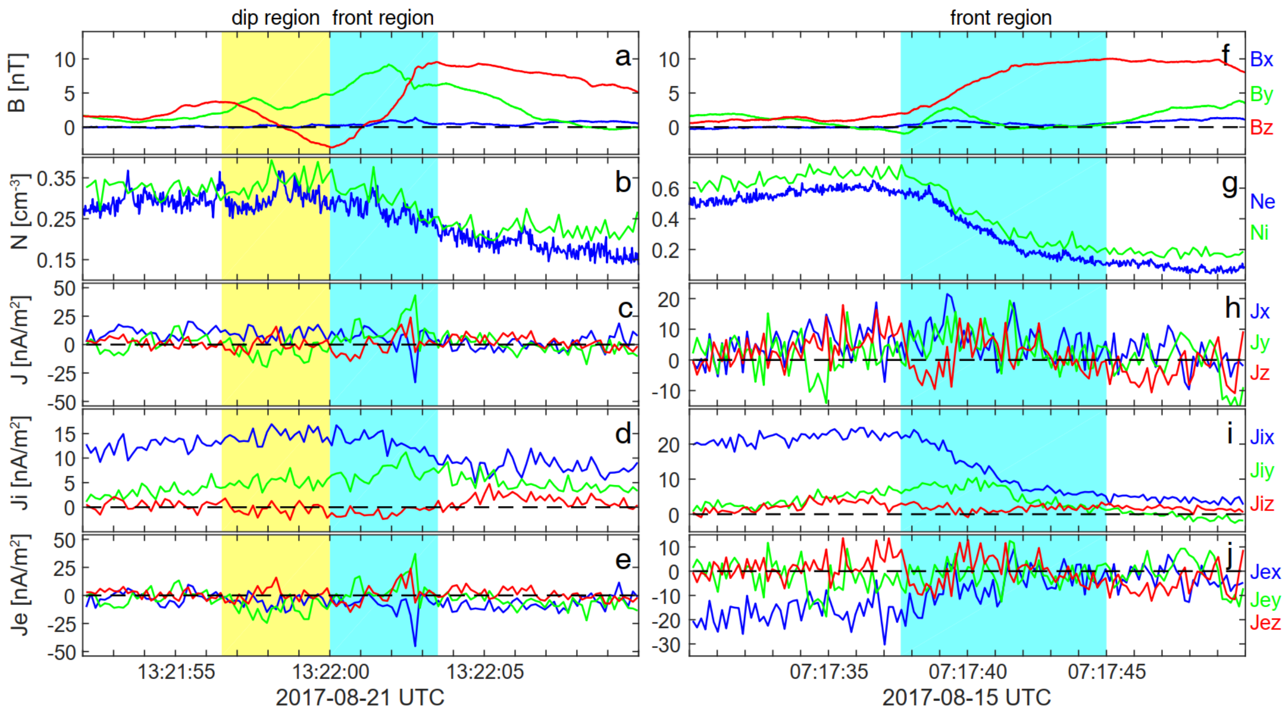

Figure 1 MMS observations of the dipolarization front with (left) and without (right) a magnetic dip ahead of it. (a and f) magnetic field components; (b and g) plasma density; (c and h) total current density (where J = Ji + Je); (d and i) ion current density; and (e and j) electron current density from MMS1.