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Statistics of the high-speed electron flows in the magnetotail

Wenya Li1, Huijie Liu1,2, Binbin Tang1, Cecilia Norgren3, Daniel Graham4, Yuri Khotyaintsev4, Daniel Gershman5, Jim Burch6, Chi Wang1

[1] State Key Laboratory of Space Weather, National Space Science Center, Chinese Academy of Sciences, Beijing, China

[2] University of Chinese Academy of Sciences, Beijing, China

[3] Department of Physics and Technology, University of Bergen, Bergen, Norway

[4] Swedish Institute of Space Physics, Uppsala, Sweden

[5] NASA Goddard Space Flight Center, Greenbelt, MD, USA

[6] Southwest Research Institute, San Antonio, Texas, USA

e-mail (speaker): wyli@spaceweather.ac.cn

High-speed electron flows play an important role in forming the thin current sheet and conversing and dissipating the magnetic energy in the terrestrial magnetosphere. NASA's Magnetospheric Multiscale (MMS) mission[1] provides the first opportunity to resolve the detailed processes of electrons in space. In the terrestrial magnetotail, several event studies reported the high-speed electron flows in the regions related with magnetic reconnection, e.g., the vicinity of electron diffusion regions (EDRs)[2], and the separatrix layer[3]. However, the general distribution and properties of the high-speed electron flows are still not clear and need statistical analysis.

Here, we perform a systematic survey of the high-speed electron flows in the magnetotail using the MMS observations from 2017 to 2021. The high-speed electron flows are characterized by electron bulk speeds exceeding 5,000 km/s, and we identified 648 events in total. Figure 1 shows an example of such events in an EDR of magnetic reconnection. The plasma moments are re-calculated to remove the contaminations caused by penetrating radiation in ion data and secondary electrons in electron data.

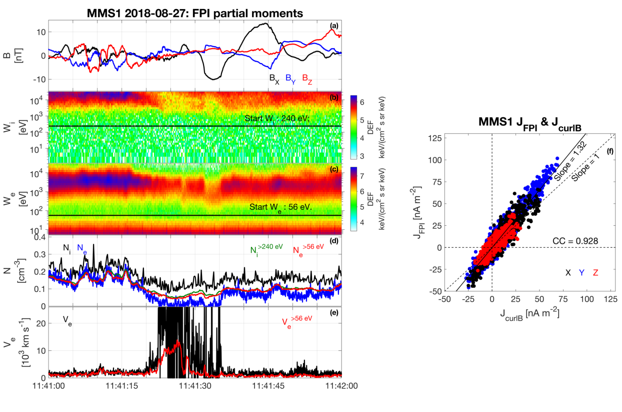

Figure 1. High-speed electron flows observed in the electron diffusion region by MMS. The plasma moments are re-calculated to remove the contaminations caused by penetrating radiation in ion data and secondary electrons in electron data.

As shown in Fig. 2, all these events demonstrate unambiguous dawn-dusk asymmetry, and 73% of them locate in the dusk magnetotail. More than 90% of them are identified in the separatrix boundary layer and the lobe region, where the electron flows are predominantly aligned with the ambient magnetic field. The rest events, with magnetic field smaller than 5 nT, locate near the plasma-sheet neutral line, and the electron flows point arbitrarily with the ambient magnetic field. Approximately 20 events among those events have EDR signatures, and we are working on detailed analysis to identify the EDR events. In this talk, we also show other statistical properties, including plasma beta, sonic Mach number, energy conversion rate, and temperature anisotropy.

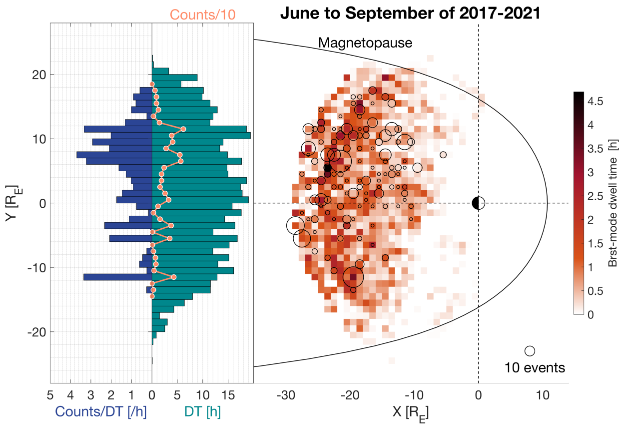

Figure 2. Dawn-dusk asymmetry of the high-speed electron flows using five-year MMS magnetotail phase data.

References
[1] Burch *et al*., Space Sci. Rev., 199, 5-21 (2016).
[2] Torbert et al., Science, 362, 1391-1395 (2018).
[3] Norgren et al., JGR, 125, e2019JA027440 (2019).