7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Energy Dissipation in the Turbulent Outflow during Magnetic Reconnection

S. Y. Huang[1], J. Zhang[1], Z. G. Yuan[1], Q. Y. Xiong[1], K. Jiang[1], S. B. Xu[1], Y. Y. Wei[1], R. T. Lin[1], L. Yu[1], and Z. Wang[1]

[1] School of Electronic Information, Hubei Luojia Laboratory, Wuhan University

e-mail (speaker): shiyonghuang@whu.edu.cn

Magnetic reconnection is an essential physical process in space, astrophysical, and laboratory plasmas, and it can effectively convert magnetic energy into particle energy accompanied by the change of magnetic field topology in a short time period. It has already been confirmed that magnetic reconnection can produce turbulent reconnection outflows. How and where the energy dissipation takes place in reconnection outflows remains a remarkable open question until now. Thanks to the unprecedented high time resolution data of the Magnetospheric Multiscale (MMS) mission, we investigate the energy dissipation in turbulent reconnection outflow in the terrestrial magnetotail. It is found that this reconnection outflow has plenty of intermittent structures at kinetic scales accompanied by abundant current filaments. Strong energy dissipation occurs in the intermittent structures with a high partial variance of increments (PVI) index, and the regions with strong current filaments. Further analyses reveal that electron heating with the presence of increase in electron temperature occurs in the intermittent structures and the regions with strong currents. This electron heating is more significant in the component parallel to the magnetic field. Our observations reveal that intermittent dissipation at kinetic scales with strong currents occurs in the turbulent reconnection outflow. Moreover, we apply a local streamline-topology classification methodology to investigate the categorization of the magnetic-field topological structures at kinetic scales in the turbulent reconnection outflow. It is found strong correlations between the straining and rotational part of the velocity gradient tensor as well as the magnetic-field gradient tensor. Strong energy dissipation prefers to occur at regions with high magnetic stress, which is contributed mainly by O-point topologies. These results indicate that the O-point topology plays a great import role in energy dissipation at kinetic scales in turbulent reconnection outflow.

References

[1] Huang, S. Y., Zhang, J., Yuan, Z. G., Jiang, K., Wei, Y. Y., Xu, S. B., et al. (2022). Intermittent dissipation at kinetic scales in the turbulent reconnection outflow. Geophysical Research Letters, 49, e2021GL096403. https://doi. org/10.1029/2021GL096403

[2] Zhang, J., Huang, S. Y., Sahraoui, F., Andrés, N., Yuan, Z. G., Jiang, K., et al. (2023). Topology of magnetic and velocity fields at kinetic scales in incompressible plasma turbulence. Journal of Geophysical Research: Space Physics, 128, e2022JA031064. https://doi. org/10.1029/2022JA031064