4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Disturbance of the front region of magnetic reconnection outflow jets due to the lower-hybrid drift instability

Takuma Nakamura[1], Takayuki Umeda[2], Rumi Nakamura[1], Huishan Fu[3], and Mitsuo Oka[4]
[1]Space Research Institute, Austrian Academy of Sciences, Graz 8042, Austria
[2]Institute for Space-Earth Environmental Research, Nagoya University, Nagoya 464-8601, Japan
[3]School of Space and Environment, Beihang University, Beijing 100083, China
[4]Space Sciences Laboratory, University of California, Berkeley, California, USA
e-mail (speaker):takuma.nakamura@oeaw.ac.at

Magnetic reconnection is a key process in collisionless plasmas that converts magnetic energy to plasma kinetic energies through changes in the magnetic field topology. The energy conversion in this process is believed to cause various explosive phenomena in space such as auroral substorms in the Earth's magnetosphere and solar flares. Here, a 3-D fully kinetic simulation shows that the lower-hybrid drift instability (LHDI) disturbs the front of magnetic reconnection outflow jets and additionally causes the energy dissipation [1]. The peak energy dissipation at the jet fronts is comparable to the values seen near the center of the reconnection region where the topology change during reconnection occurs [2], indicating that the LHDI turbulence has a substantial effect on the energetics of reconnection. The disturbed structure of the jet fronts seen in the simulation is quantitatively consistent with an observation event of the dipolarization front (DF) in the Earth's magnetotail by the Magnetospheric Multiscale (MMS) mission [3]. This naturally suggest that the LHDI-driven turbulence and the resulting energy dissipation at the jet fronts as seen in the present simulation may really occur in the Earth's magnetotail. Furthermore, a fully kinetic dispersion relation solver [4], which is validated by the MMS observations, further predicts that the disturbance of the reconnection jet front could frequently occur over different parameter regimes in space plasmas including the Earth's magnetotail and solar flares [5].

References:

[1] Nakamura, T. K. M., R. Nakamura, W. Baumjohann, T. Umeda, and I. Shinohara (2016), Three-dimensional development of front region of plasma jets generated by magnetic reconnection, *Geophys. Res. Lett.*, *43*, 8356-8364, https://doi.org/10.1002/2016GL070215.

[2] Nakamura, T. K. M., Genestreti, K. J., Liu, Y.-H., Nakamura, R., Teh, W.-L., Hasegawa, H., et al. (2018). Measurement of the magnetic reconnection rate in the Earth's magnetotail. *Journal of Geophysical Research*, 123, 9150-9168, doi:10.1029/2018JA025713

[3] Liu, C. M., Fu, H. S., Xu, Y., Khotyaintsev, Y. V., Burch, J. L., Ergun, R. E., et al. (2018). Electron-scale measurements of dipolarization front. *Geophysical Research Letters*, 45, 4628-4638. https://doi:/10.1029/2018GL077928

[4] Umeda, T. & T. K. M. Nakamura (2018), Electromagnetic linear dispersion relation for plasma with a drift across magnetic field revisited, Physics of Plasmas, 25, 102109, https://doi.org/10.1063/1.5050542

[5] Nakamura, T. K. M., T. Umeda, R. Nakamura, H. S. Fu and M. Oka (2019), Disturbance of the Front Region of Magnetic Reconnection Outflow Jets due to the Lower-Hybrid Drift Instability, *Physical Review Letters* 123, 235101, 10.1103/PhysRevLett.123.235101