MMS Observations of Short-Period Current Sheet Flapping

Louis RICHARD[1,2] Yuri KHOTYAINTSEV[1] Daniel GRAHAM[1]
Christopher RUSSELL[3] Olivier LE CONTEL[4]

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

[2]Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden

[3]Department of Earth and Space Sciences, University of California, Los Angeles, California, USA

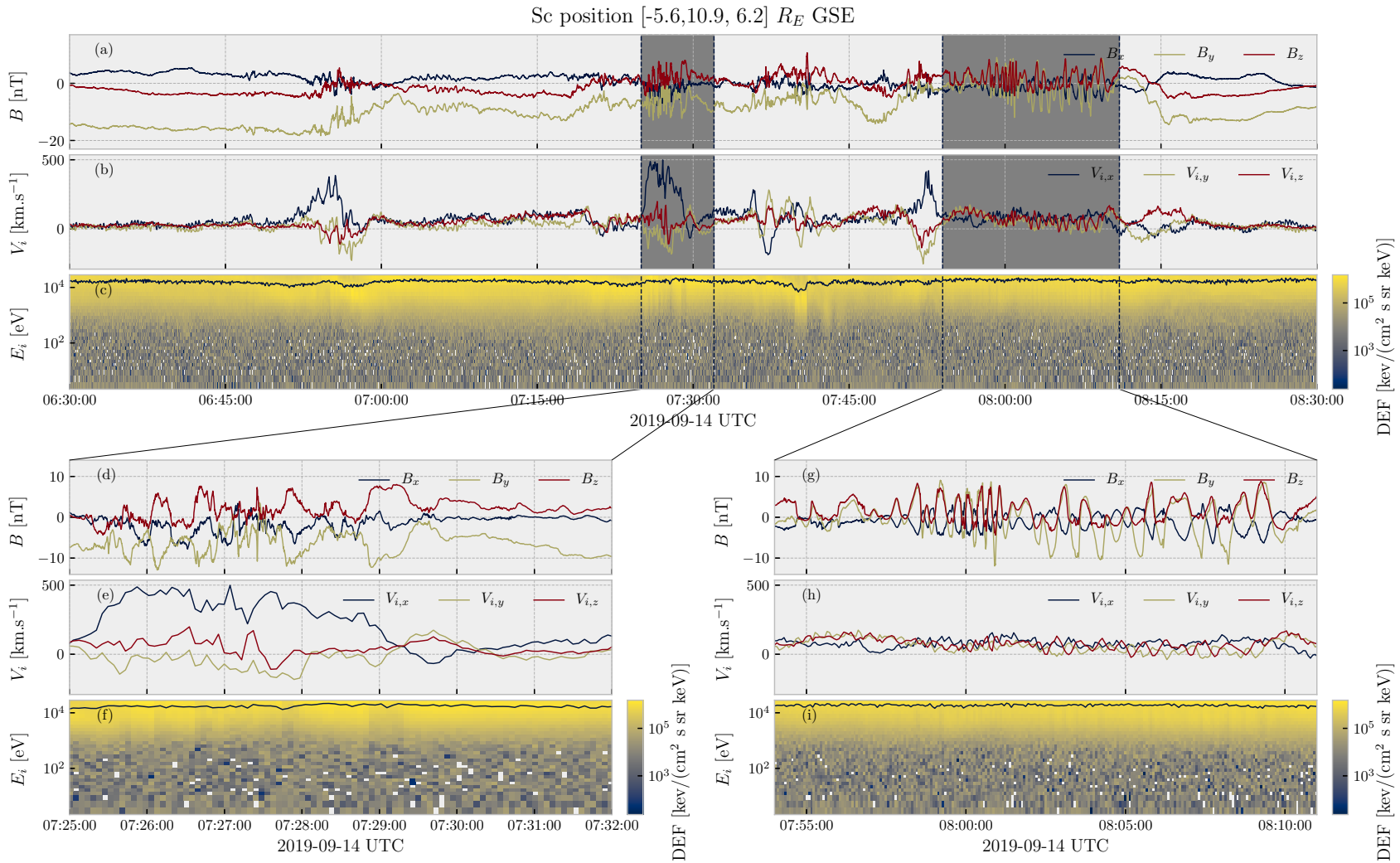
[4]Laboratoire de Physique des Plasmas, CNRS/Ecole Polytechnique/Sorbonne Université/Univ. Paris Sud/Obs. de Paris, Paris, France

Motivation

1. Low frequency oscilations of the magnetic field with multiple zero crossings
2. What kind of motion of the current sheet leads to this signature ?
3. How the kink like current sheet is propagating ?
4. How ions and electrons would behave in a current sheet oscilating with ion scale wavelength ?
5. Does a short wavelength oscilation of the current sheet mean that the current sheet is thin?

Overview

- Time interval of interest : 07:54:00 UTC → 08:11:00 UTC



Ion demagnetization

Global MVA frame :

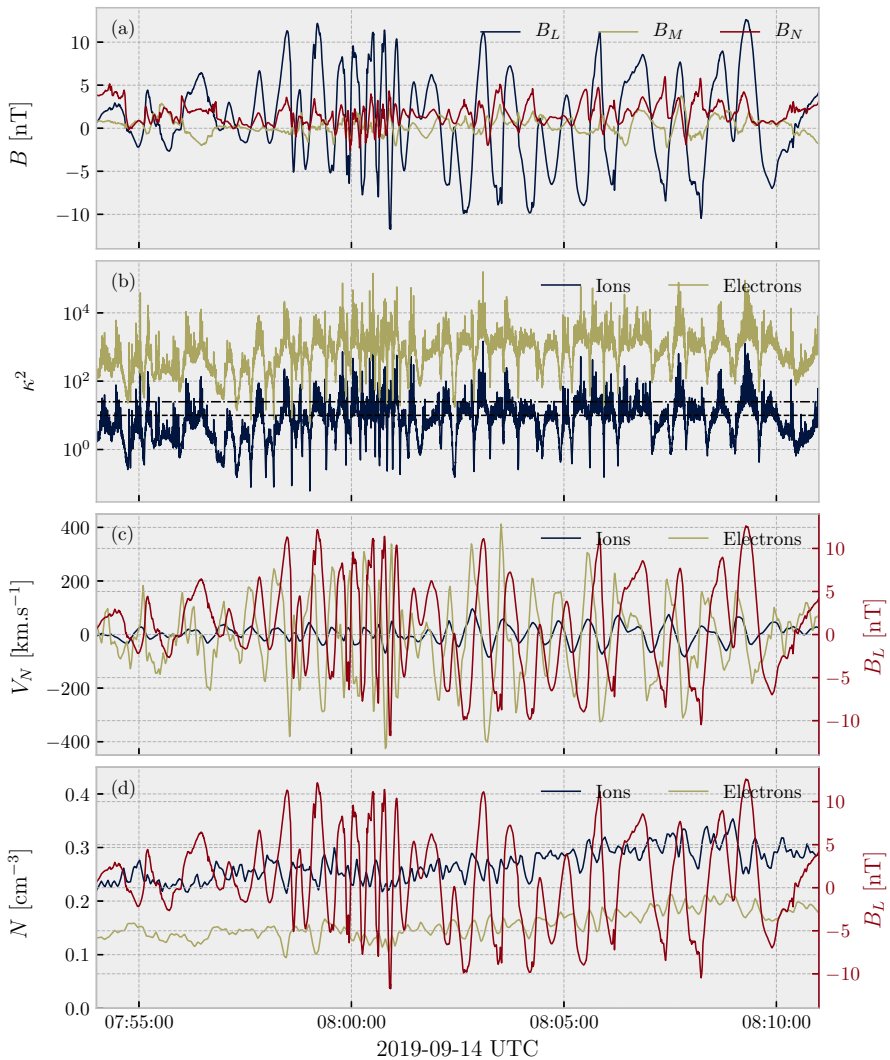
	X [GSE]	Y [GSE]	Z [GSE]
L	-0.32	0.81	0.48
M	-0.9	-0.1	-0.43
N	-0.31	-0.57	0.76

Adiabacity condition [Büchner and Zelenyi, 1989] :

$$\kappa^2 = R_c/r_i > 25$$

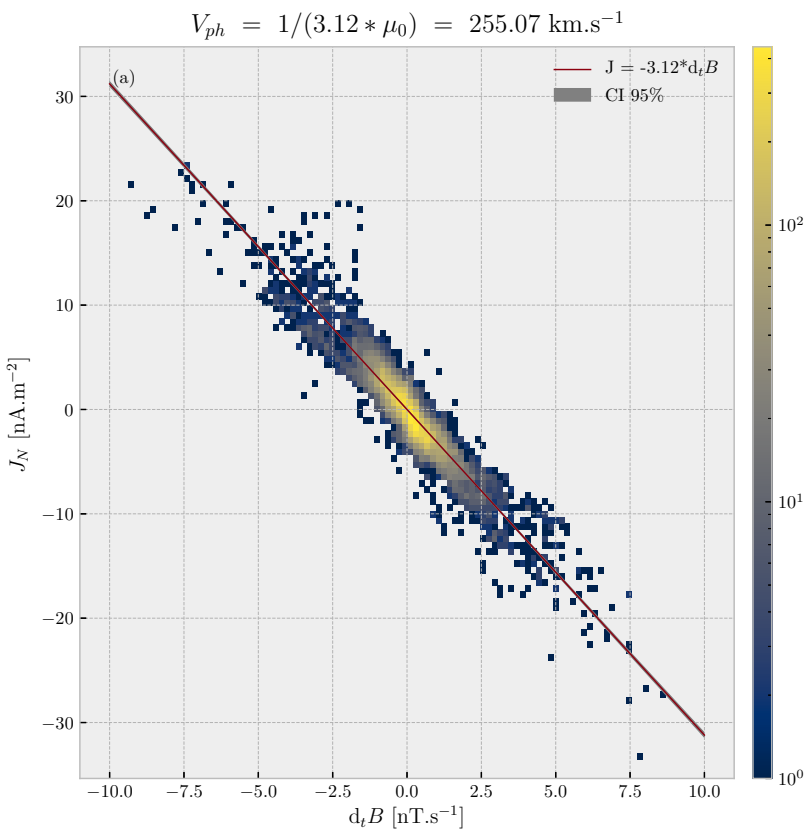
B_L correlated with V_N and $n_{e/i}$

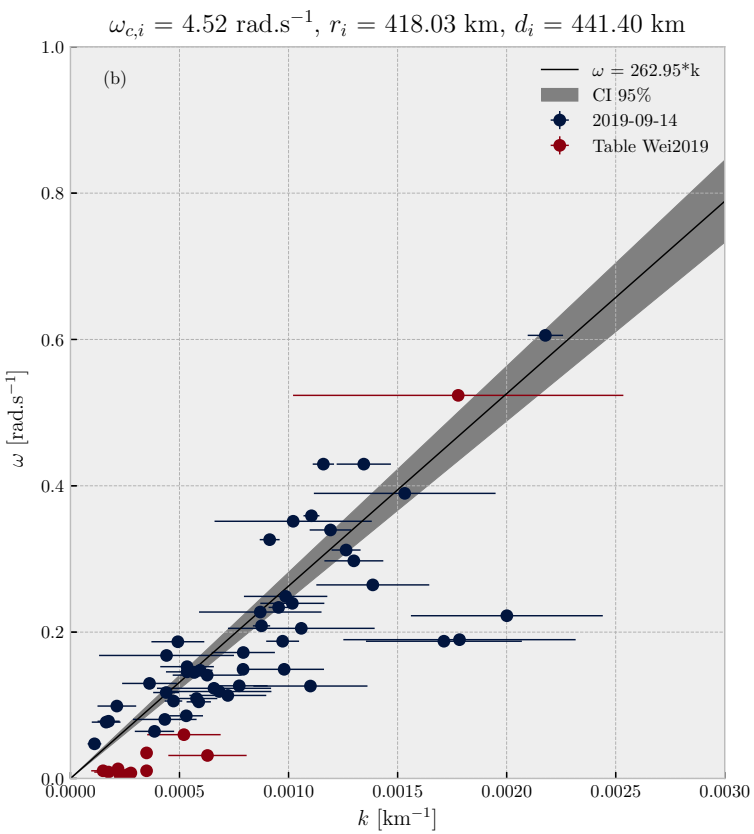
$$\varphi_{B,V_N} = \varphi_{B,n} = 90^\circ$$



Dispersion relation

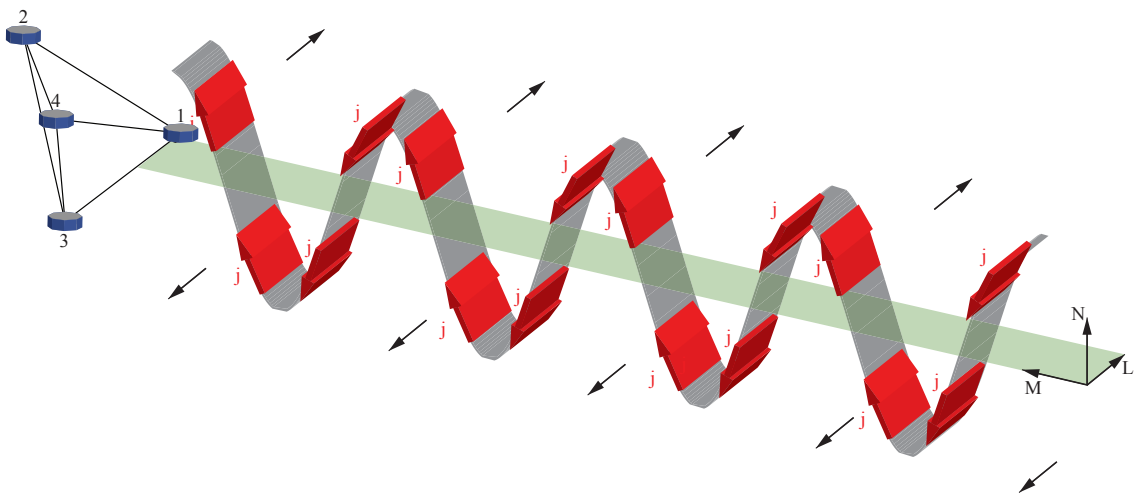
- $\mathrm{d}_t B_L$ and J_N correlated, $-ik_M B_L \approx \mu_0 |a| i\omega B_L$, $V_{ph,J} \approx 255\ \mathrm{km.s^{-1}}$
- Timing method normal $\boldsymbol{N_{TM}}.\boldsymbol{M} < 0$, $V_{ph,TM} \approx 263\ \mathrm{km.s^{-1}}$



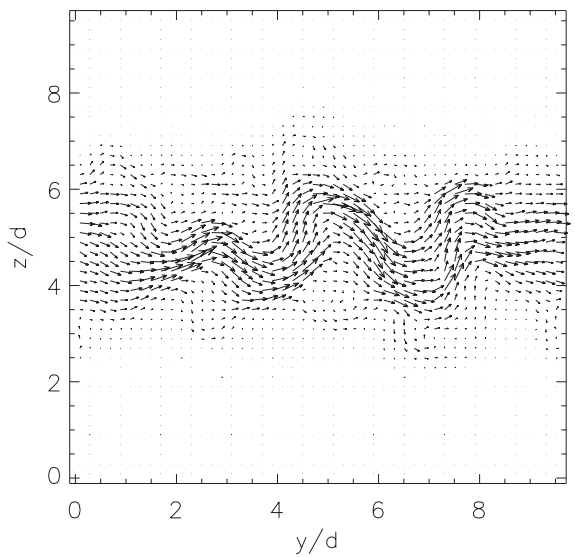


Conclusion

1. Propagation along the current density (i.e $-\boldsymbol{M} \sim \boldsymbol{x_{GSE}}$)
2. Demagnetization of ions, wavelength $\lambda_{FM} \sim d_i \Rightarrow$ thin current sheet ?



(a)



(b) [Sitnov et al., 2006]

Thank you for your attention

References I

Büchner, J. and Zelenyi, L. M. (1989).
Regular and chaotic charged particle motion in magnetotaillike field reversals: 1. Basic theory of trapped motion.
Journal of Geophysical Research, 94(A9):11821.

Sitnov, M. I., Swisdak, M., Guzdar, P. N., and Runov, A. (2006).
Structure and dynamics of a new class of thin current sheets.
Journal of Geophysical Research, 111(A8):A08204.

Wei, Y. Y., Huang, S. Y., Rong, Z. J., Yuan, Z. G., Jiang, K., Deng, X. H., Zhou, M., Fu, H. S., Yu, X. D., Xu, S. B., He, L. H., and Deng, D. (2019).
Observations of Short-period Current Sheet Flapping Events in the Earth's Magnetotail.
The Astrophysical Journal, 874(2):L18.