### Statistical Relationship between IMF Conditions and the Helicity Sign of FTE Flux Ropes

**R. Kieokaew**, B. Lavraud, N. Fargette, A. Marchaudon, V. Génot, C. Jacquey, D. Gershman, B. Giles, R. Torbert, and J. Burch

Question: Is handedness of FTE flux ropes determined by IMF condition?

From topological consideration, if an FTE flux rope is formed by multiple X-line reconnection between the draped IMF in the magnetosheath and the magnetospheric field at the MP, the handedness should be determined by IMF  $B_{\gamma}$ .



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300

275

23:45:10

23:45:20

(nPa)

### Flux rope model (Burlaga, 1988)

0.6 -

-0.2

Cylindrically symmetric and force-free  $\nabla \times B = \alpha B$  with a MMS1 23 Jan 2016 constant  $\alpha$ . The solution is found by Lundquist (1950) in 25 - (a) <sub>50</sub> - (a')  $B_{t,max} = 31.5$ terms of 0<sup>th</sup> and 1<sup>st</sup> order Bessel functions (nT) (nT) Axial component:  $B_A = B_0 J_0(\alpha R)$ Bz. GSE -25 -50 Tangential component:  $B_T = B_0 H I_1(\alpha R)$ (b) (km.s<sup>-1</sup>) (km.s<sup>-1</sup>)  $x_v = [0.677, 0.726, 0.118]$ -100 $y_v = [-0.734, 0.671, 0.084]$ -50 Radial component:  $B_R = 0$  $z_{\nu} = [-0.018] - 0.144$ . 0.987 -150 $\theta_0 = -48.0^\circ, \phi_0 = 62.0^\circ$  $v_0 = 0.1R_F$ . H = 0.5 0.5 Bx. B<sub>t, max</sub> B<sub>t, max</sub> *H* is helicity sign -0.5 -0.5 Bz. H = +1 (RH)H = -1 (LH)15 (cm<sup>-3</sup>) (cm<sup>-3</sup>) 24 FR num: 23  $0.8 \quad \theta_0 = 0.0^\circ, \phi_0 = -47.0^\circ$  $0.8 \quad \theta_0 = 0.0^\circ, \phi_0 = -49.0^\circ$ 10 0.6 y<sub>0</sub> = -1.0R<sub>E</sub>, H = 22 325 500 (eV) (eV)

#### **Example events**

MMS1 29 Jan 2017

01:57:15

 $B_{t.max} = 63.5$ 

 $y_v = [-0.899, 0.432, -0.059]$ 

 $v_0 = 0.7R_F, H = 1$ 

-0.208. -0.308

 $B_{z,GSE}$ 

Ti 🛛

01:57:25

We perform the model fitting to an ensemble of 186 FTEs (w/o RX) observed by MMS in 2015 - 2017. We found 84 flux ropes with good fit (low  $\chi^2$ ) to the model

-0.4

-0.6

59 (70%) out of 84 are RH flux ropes 25 (30%) out of 84 are LH flux ropes

23:45:30

300

(nPa)

2 - (f')

01:57:05

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#### Spatial distributions of RH and LH flux ropes

#### **Discussion and summary**



RH (LH) flux ropes are mostly preceded by southward IMF with  $B_{\gamma} > 0$  ( $B_{\gamma} < 0$ ), compatible with the multiple X-line reconnection mechanism.





However, there are some LH flux ropes that are not preceded by IMF  $B_{\gamma}$  < 0. We find that the IMF cone angle of the regular and outlier groups are different.

180°

IMF cone angle (GSE) before regular LH flux ropes (total cases: 16) 90° 45° 135°

0

0°

IMF cone angle (GSE) before outlier LH flux ropes (total cases: 9)

