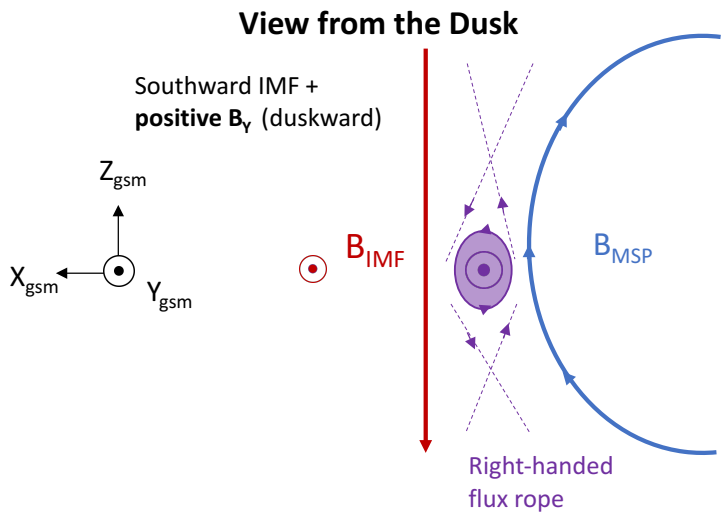
Statistical Relationship between IMF Conditions and the Helicity Sign of FTE Flux Ropes

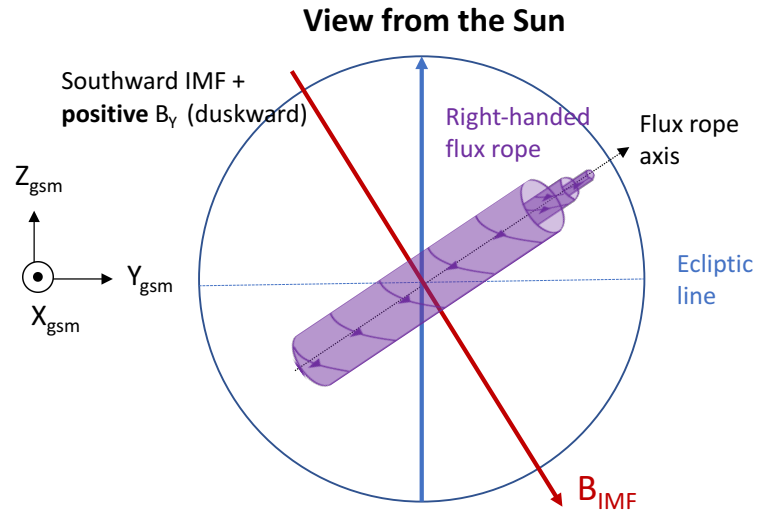
R. Kieokaew, B. Lavraud, N. Fargette, A. Marchaudon, V. Génot, C. Jacquey, D. Gershman, B. Giles, R. Torbert, and J. Burch

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_Y.

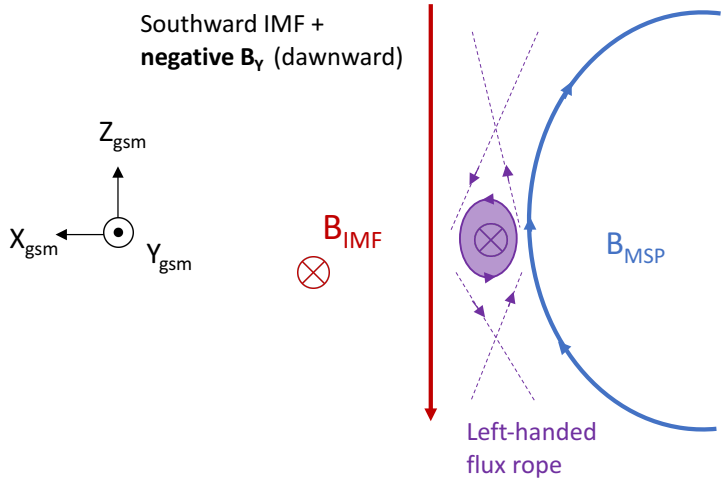
Duskward IMF
$B_Y > 0$

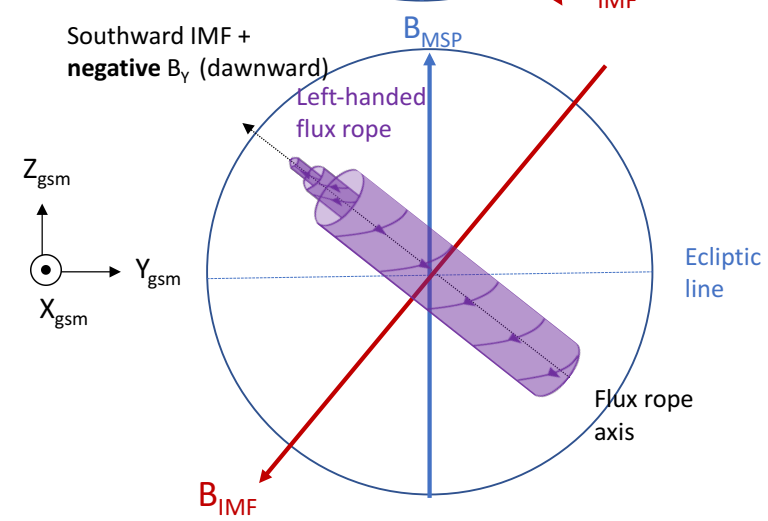




RH flux rope

Dawnward IMF
$B_Y < 0$





LH flux rope

(rkieokaew@irap.omp.eu)

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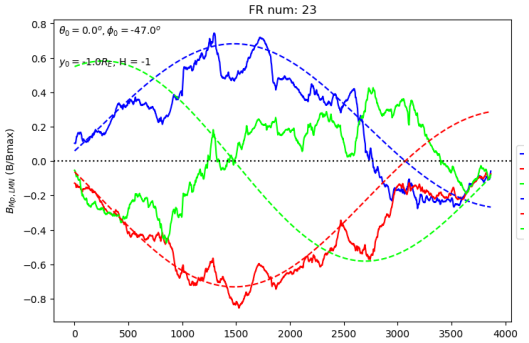
Flux rope model (Burlaga, 1988)

Cylindrically symmetric and force-free $\nabla \times B = \alpha B$ with a constant α. The solution is found by Lundquist (1950) in terms of 0th and 1st order Bessel functions

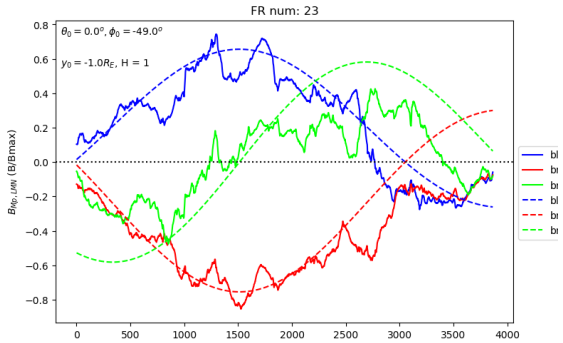
Axial component: $B_A = B_0 J_0(\alpha R)$
Tangential component: $B_T = B_0 H J_1(\alpha R)$
Radial component: $B_R = 0$

H is helicity sign

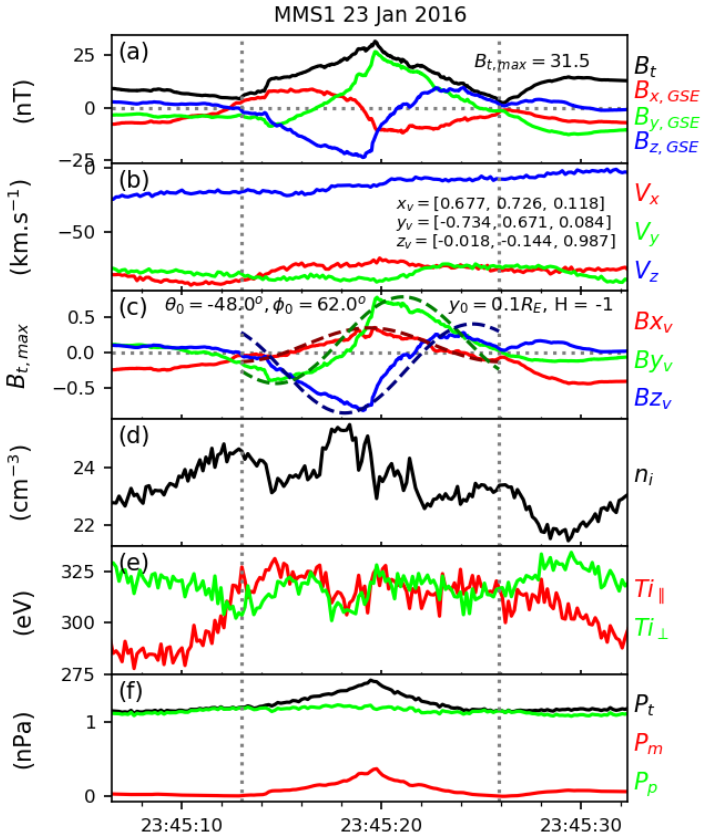
H = -1 (LH)

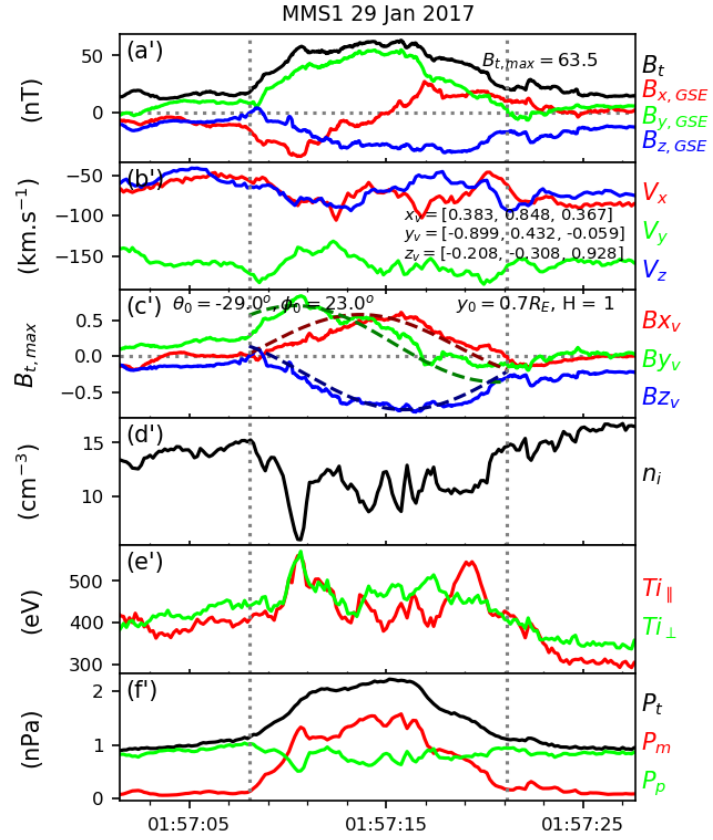


H = +1 (RH)



Example events





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 χ^2) to the model

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

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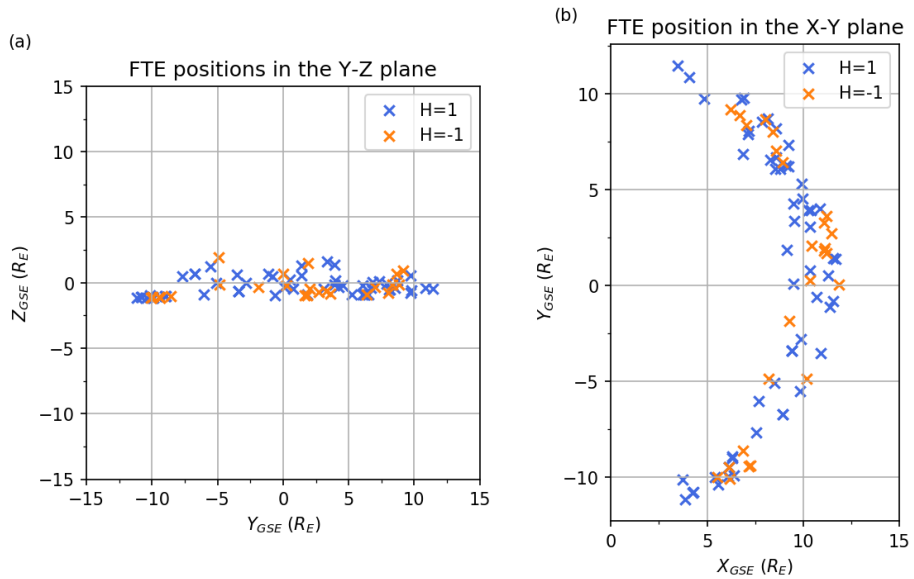
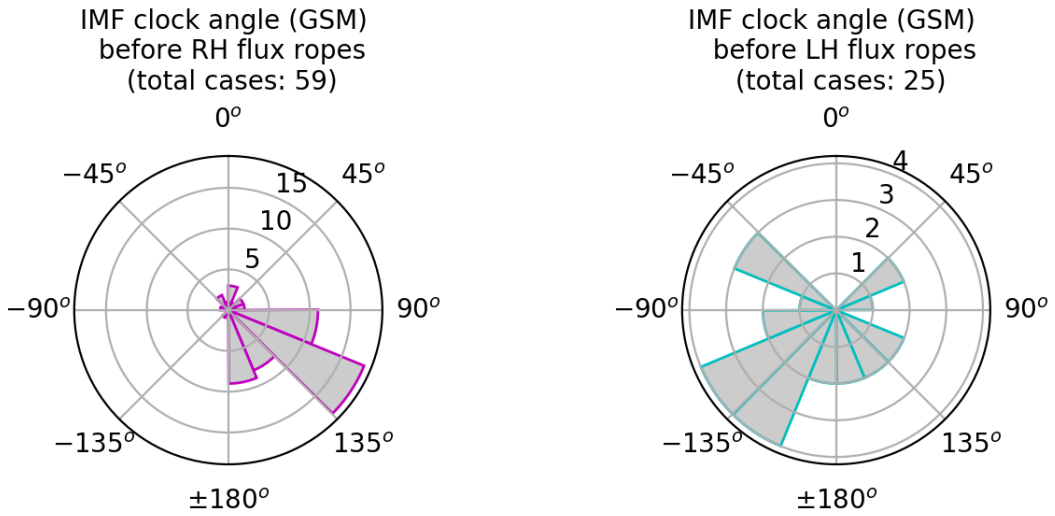
Spatial distributions of RH and LH flux ropes

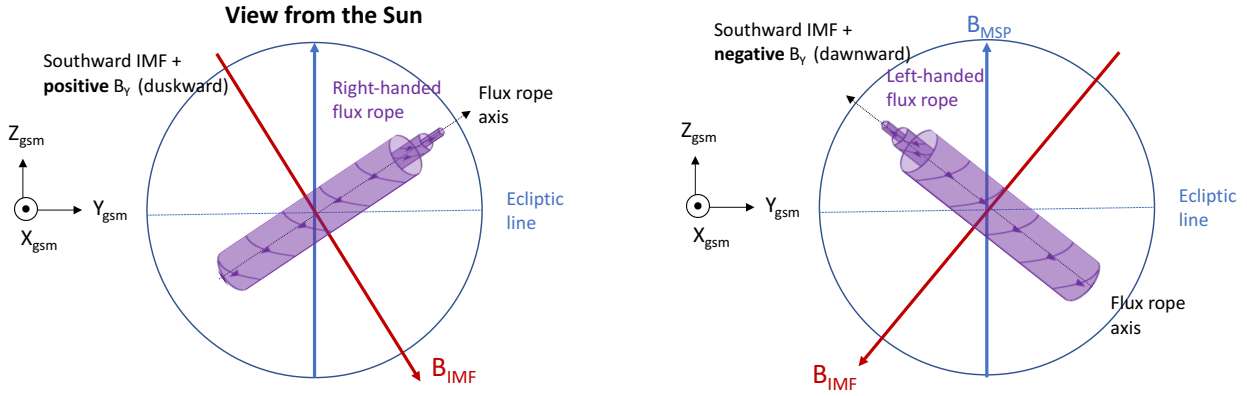


IMF clock angle preceding the events



Discussion and summary

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



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