

pause the local reconnection rate (R) is expected to follow the Cassak-Shay formula  $(R_{cs})$ <sup>[1]</sup>

where  $\delta/L$  is the aspect ratio of the diffusion region. Usually  $\rho_{sh}$  is dominant.

- We present a statistical study with Cluster to examine  $\succ$  whether the reconnection rate follows the prediction;  $\succ$  the contribution of O<sup>+</sup> and cold ions.



## Observational test of the dayside magnetopause reconnection rate

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### **Statistical results and discussions**

We investigate the reconnection rate for 10 MP reconnection events Reconnection rate (R)

- $\succ$  R generally follows R<sub>cs</sub> (Fig. 6a);

- with the guide field.

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Locations and reconnection rates					
Date	MLAT	MLT	R <sub>cs</sub> mV/m	R <sub>sh</sub> mV/m	R <sub>m</sub> mV/m
2003-05-30	42.9	5.9	3.23	2.52	$1.55 \pm 0.03$
2004-01-04	22.5	16.5	0.22	0.30	$0.57 \pm 0.21$
2004-04-06	31.1	10.2	2.10	1.57	1.29±0.16
2005-02-25	36.2	13.3	1.16	1.14	$2.25 \pm 0.13$
2005-03-09	26.8	12.3	0.52	0.25	$0.40 \pm 0.11$
2007-03-05	35.4	12.9	0.90	0.68	$0.83 \pm 0.43$
2008-03-03	3.3	13.2	0.74	0.42	0.38±0.13
2008-04-22	23.0	10.2	1.16	0.65	$1.13 \pm 0.40$
2010-02-15	4.2	15.5	1.00	1.00	0.99±0.34
2012-06-17	-23.7	9.8	2.24	2.04	2.37±1.61

Red: with high cold ion density

Blue: with high O<sup>+</sup> density

Underlined: with large guide field (angle between the

fields on two sides smaller than 140°)

> R<sub>sh</sub> with only Msh parameters correlates better with the R<sub>m</sub> (Fig. 6b) • Asymmetric plasmas might not be fully coupled as a single fluid

 $\succ$  The contribution (Fig. 6c) to the Cassak-Shay formula is usually

small; cold ions in plume can have a comparable (~50%)

contributions to Msh H<sup>+</sup>; O<sup>+</sup> contribution can be up to  $\sim 30\%$ .

> The variation of Msh (SW) conditions has a larger overall effect than the modification of Msph contribution for R (Fig. 6d).

Not correlated with O<sup>+</sup> mass density percentage (Fig. 6e), O<sup>+</sup> effect may be smaller than other factors and error bars

 $\succ$  Very weak positive correlation with guide field (Fig. 6f)

#### Conclusions

The dayside reconnection rate can be estimated with the Cassak-Shay formula. However, the estimation is better when the inflow B and n on the magnetosheath side are used, instead of the values from both sides. This may indicate that ions from different origins have different contributions to the reconnection rate, due to different scales where they can be demagnetized and the asymmetric reconnection structure.

For individual events, the contribution of cold ions and O<sup>+</sup> can be comparable to Msh H<sup>+</sup>, but statistically, the variation of Msh/SW conditions has a larger effect on the reconnection rate. The aspect ratio does not show a correlation with O<sup>+</sup>. However, the amount of O<sup>+</sup> may be too low in these events to have an effect. The aspect ratio does have a weak positive correlation

**References and Acknowledgements** [1] Cassak, P. A. and M. A. Shay, 2007, POP, 14, 10211, doi:10.1063/1.2795630; [2] Borovsky, J. E., et al., 2013, JGR, 118, doi: 10.1002/jgra.50527; [3] Walsh, B. M., et al., 2014, GRL, 41, doi: 10.1002/2013GL058802; [4] Shay, M. A. and M. Swisdak, 2004, PRL, 93, 17, doi: 10.1103/PhyRevLett.93.175001; [5] Wang, S., et al., 2014, JGR, 119, doi:10.1002/2014JA020402. [6] Khrabrov, A. V. and B. U. Ö. Sonnerup, 1998, GRL, 25, 13, doi: 10.1029/98GL51784. Work at UNH was supported by NASA under NNX12AD16G.