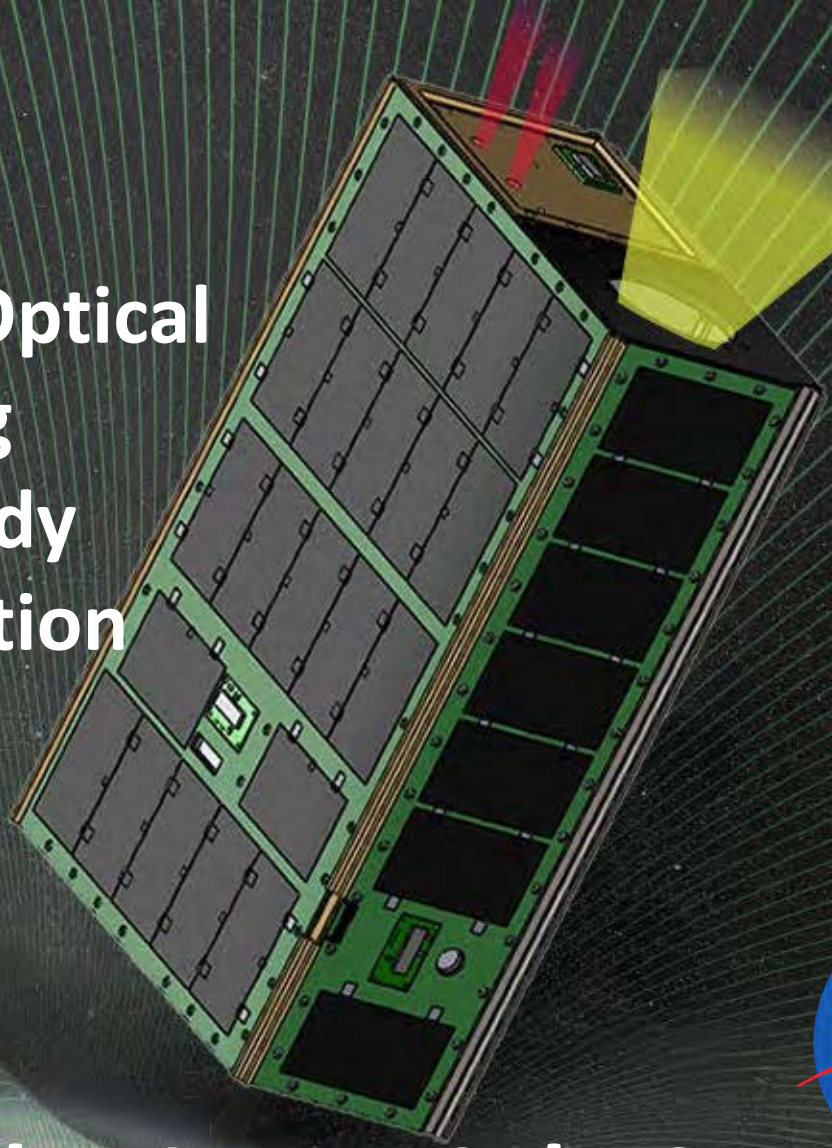
BOSTON UNIVERSITY

Combining In-situ, Optical and Remote Sensing Observations to Study Magnetic Reconnection

Emil A. Atz[1]



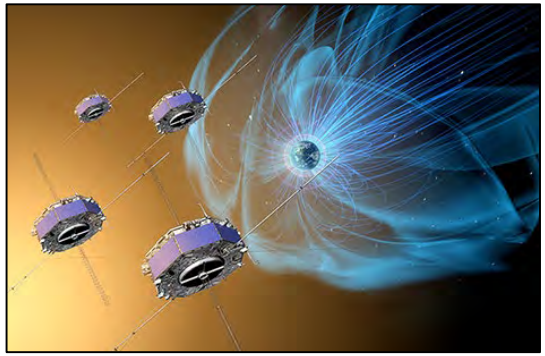
The CuPID CubeSat

B.M. Walsh[1], L.J. Billingsley[2], J. Broll[1], M.R. Collier[2], H.J. Connor[3], N. Dobson[2], J. Kujawski[4], K.D. Kuntz[5], F.S. Porter[2], D.G. Sibeck[2], K. Simms[2], N.E. Thomas[2], D.L. Turner[6], A. Weatherwax[7], A. Yousuff[4], A. Zosuls[1]

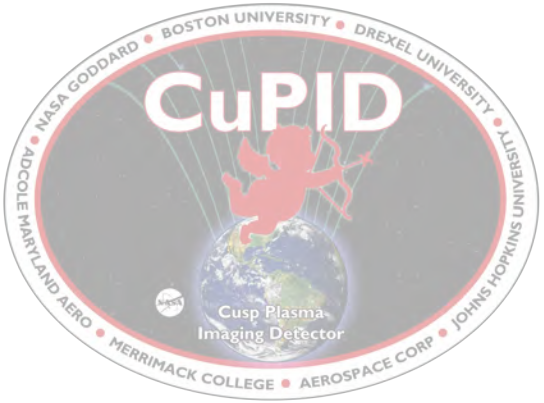
[1] Boston University, Center for Space Physics; [2]NASA Goddard Space Flight Center; [3] University of Alaska; [4]Drexel University; [5]The Henry A. Rowland Department of Physics and Astronomy, Johns Hopkins University; [6]Space Science Applications Laboratory, The Aerospace Corporation; [7]Merrimack College

Combining ***In-situ***, Optical and Remote Sensing Observations to Study Magnetic Reconnection

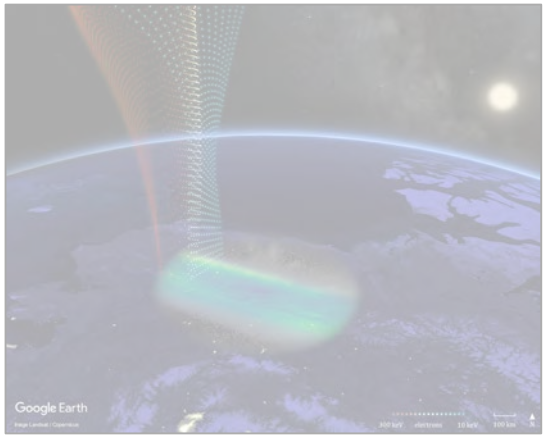
What do current studies look like?



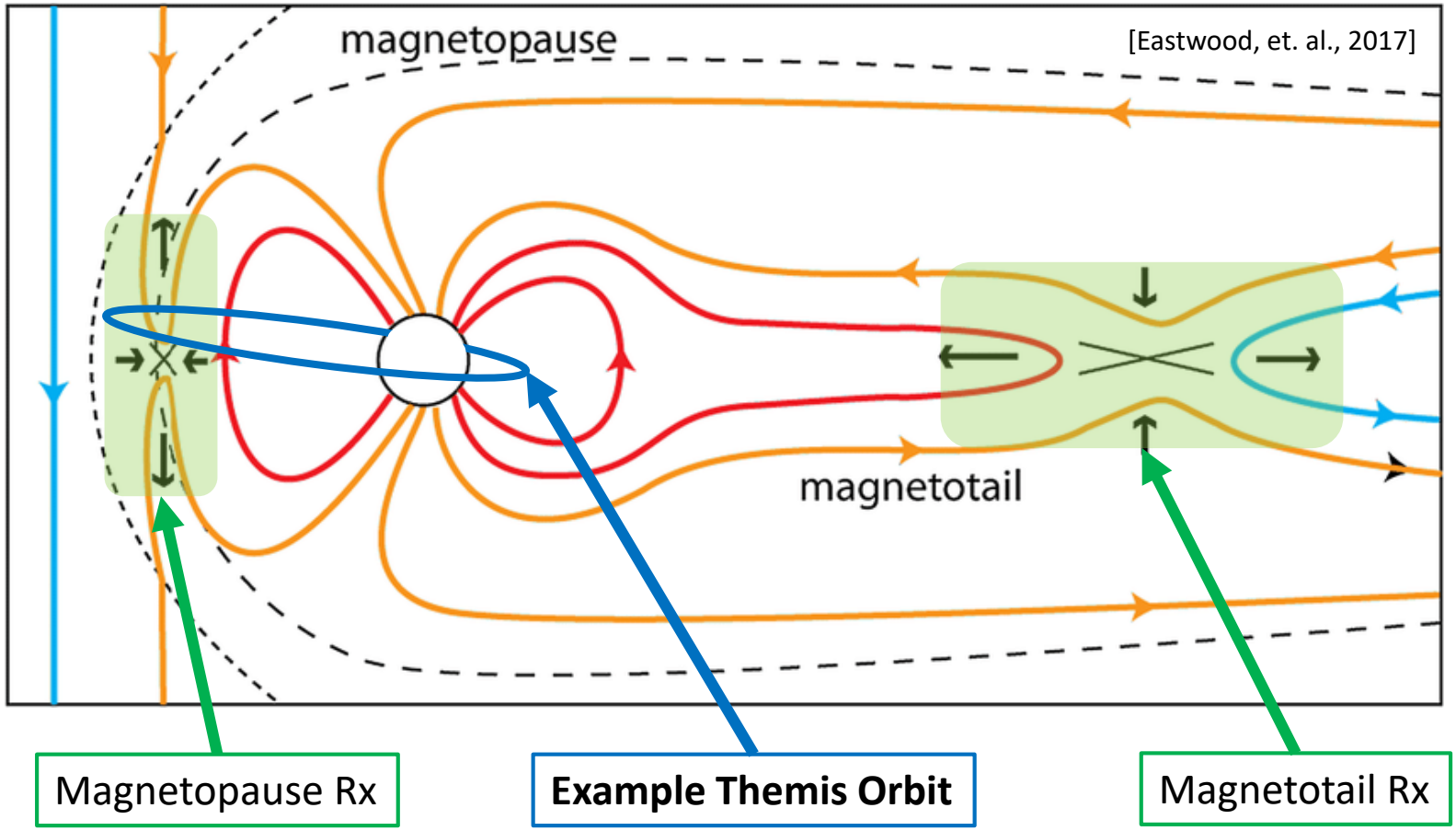
What is the CuPID method?



What are the next steps?



Many reconnection studies involve measuring current sheet properties In-Situ.



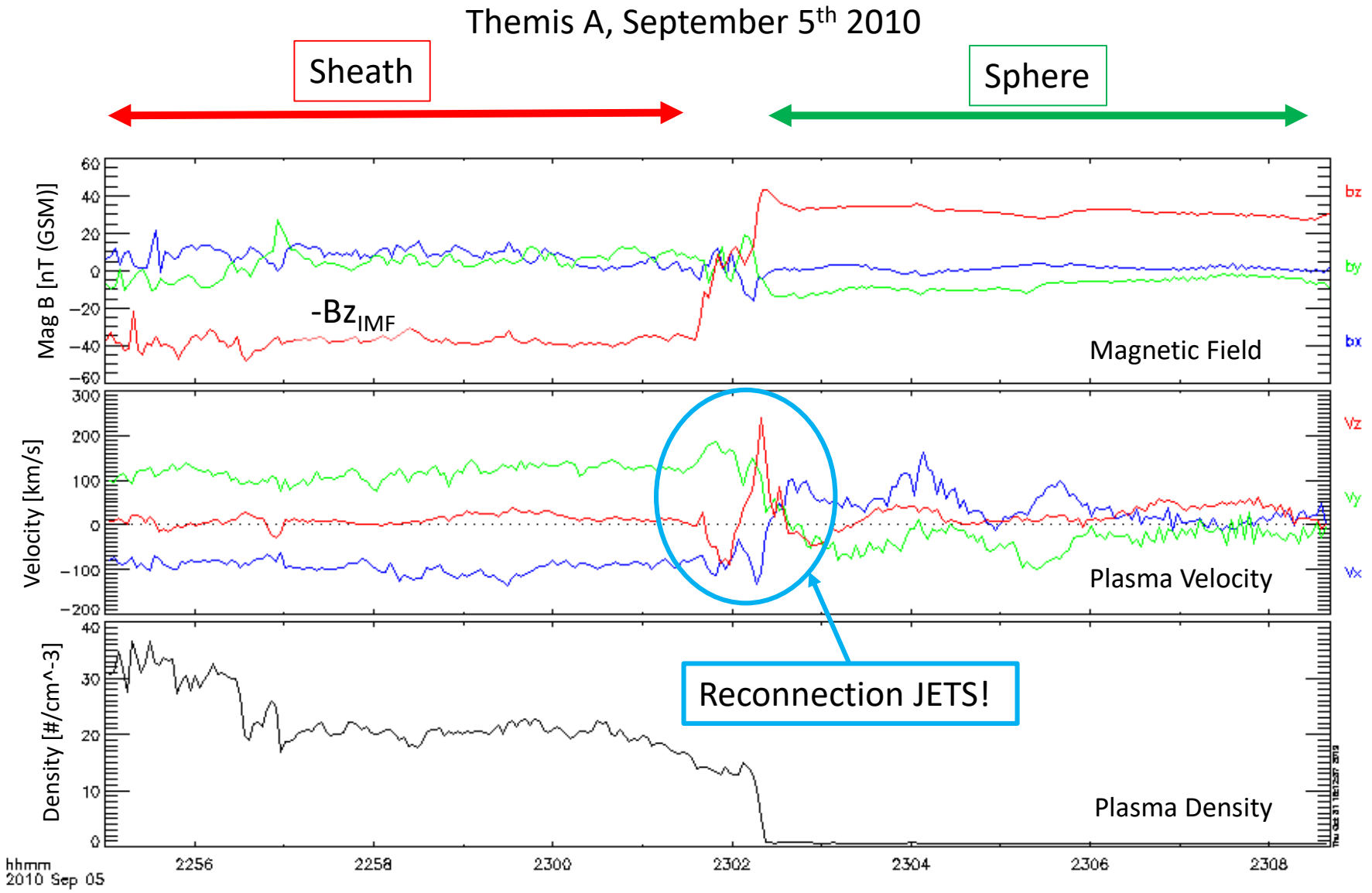
Asymmetric: Variations in
- Pressure
- Density
- Clock Angle… etc

= ***IN***consistent driving

The orbit crosses the magnetopause providing 'in-situ' measurements
- MMS too!

Symmetric: More consistent properties on either side of X-line
= consistent driving

What does reconnection look like in THEMIS data?

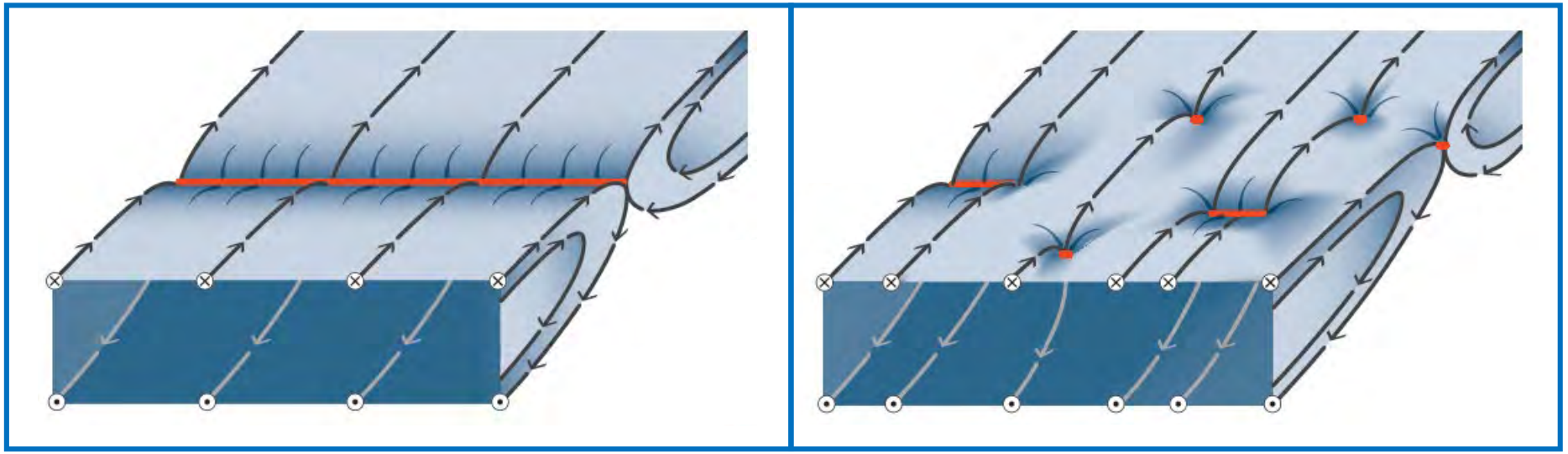


Global properties of magnetic reconnection are still unknown.

Spatially Patchy or Extended?
Temporally Intermittent or Continuous?

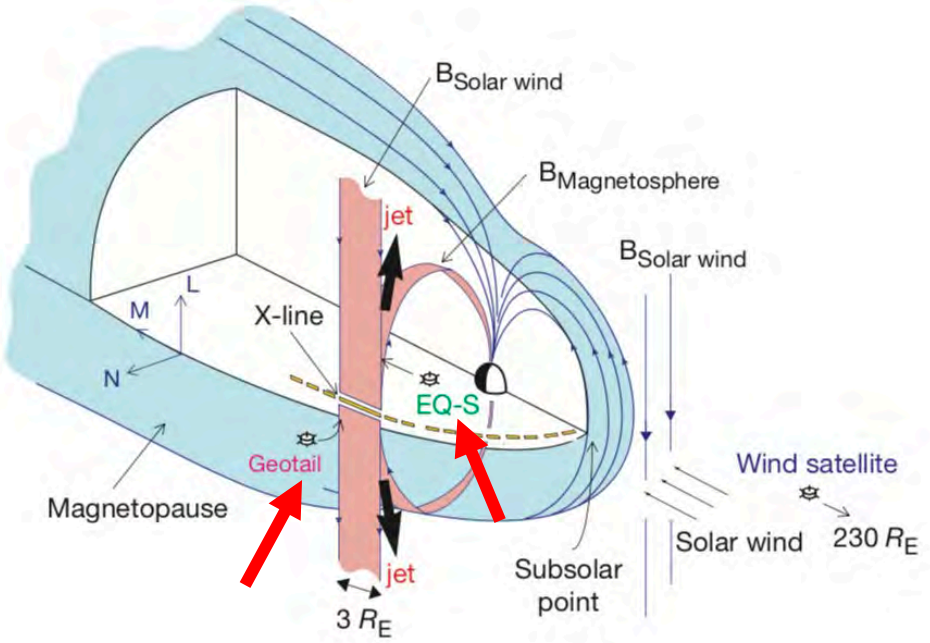
Single, continuous X-line

Patchy, spatially intermittent X-line



[Adapted from B.M. Walsh]

Competing conclusions from experimentalists and modelers



T.D. Phan, et. al., 2000 [Nature]

- Geotail and EQ-S spacecraft
- Observe North and South reconnection jets above and below equator
- Separated by $3R_E$ in longitude

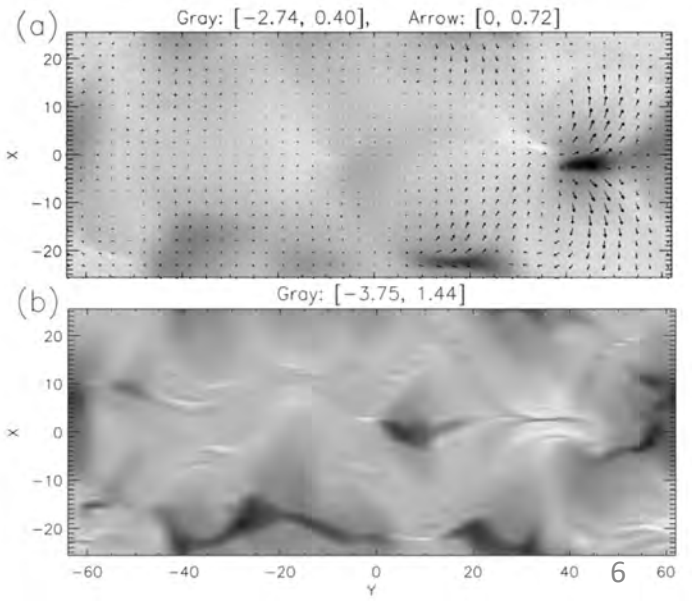
Concludes:

X-line must be $3R_E$ or more!

[M. Shay, et. al., 2003]

- A) Thick current sheet = separate x-lines
- B) Thin current sheet = separate x-lines that become long x-lines

Properties of Reconnection Depend on Conditions



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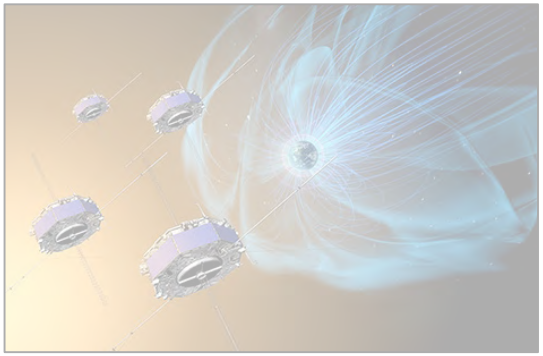

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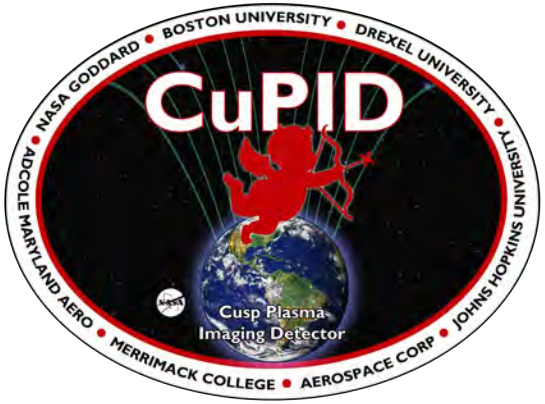
What is the CuPID method?



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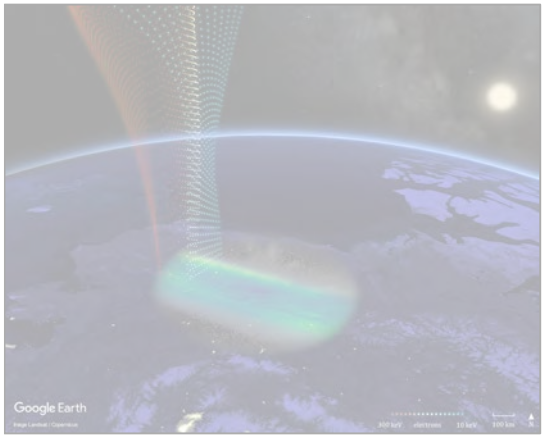
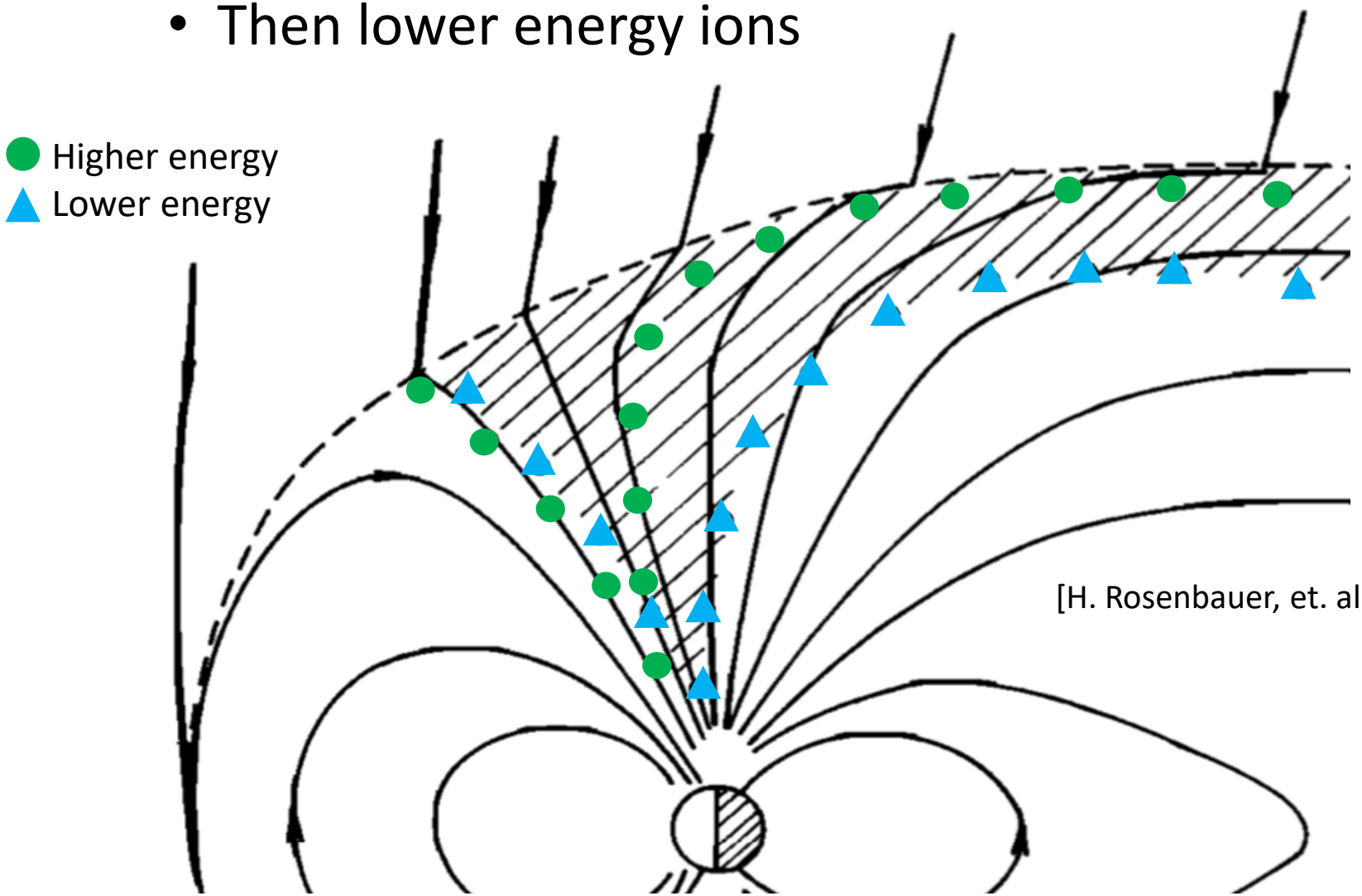


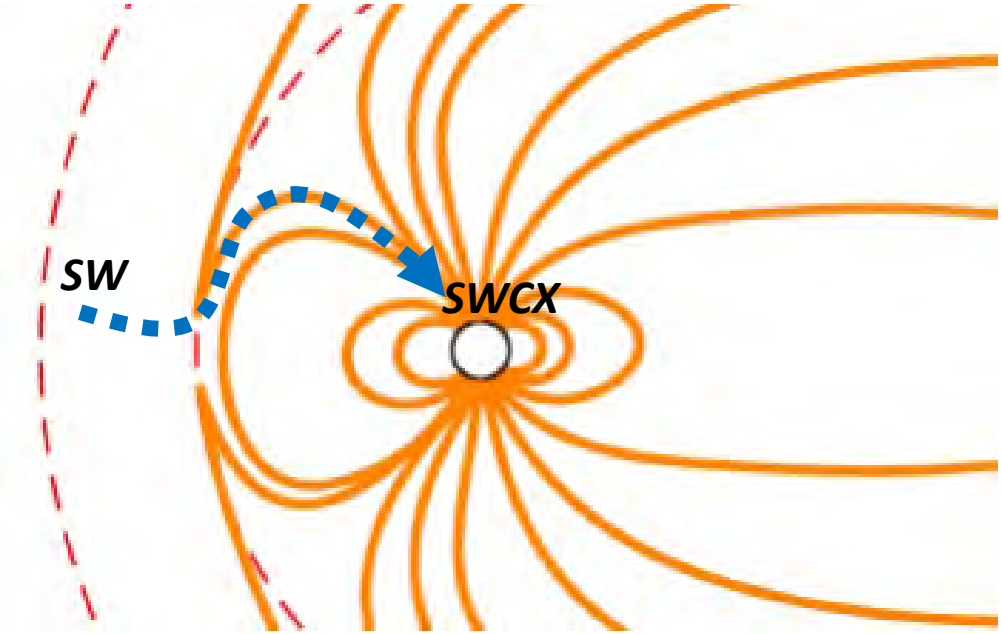
Magnetic reconnection accelerates high charge state plasma into the magnetospheric cusps.

- High energy ions inject and reflect **first**
- Then lower energy ions

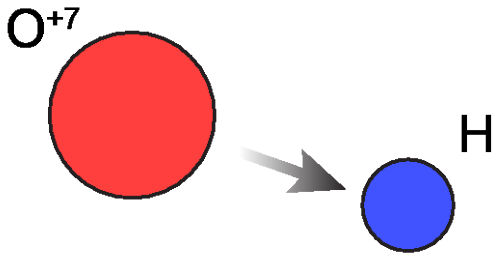


[H. Rosenbauer, et. al., 1975]

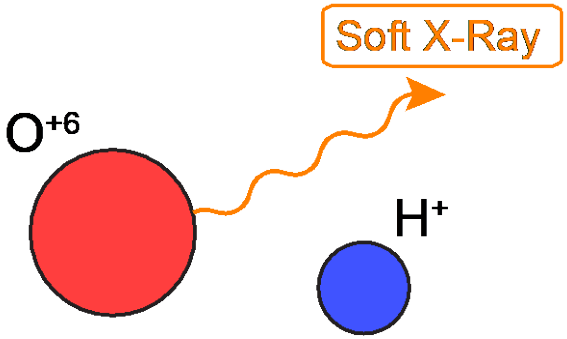
High charge state plasma in the cusps interacts with neutrals to create soft X-rays.



Step 1: Collision



Step 2: Emission



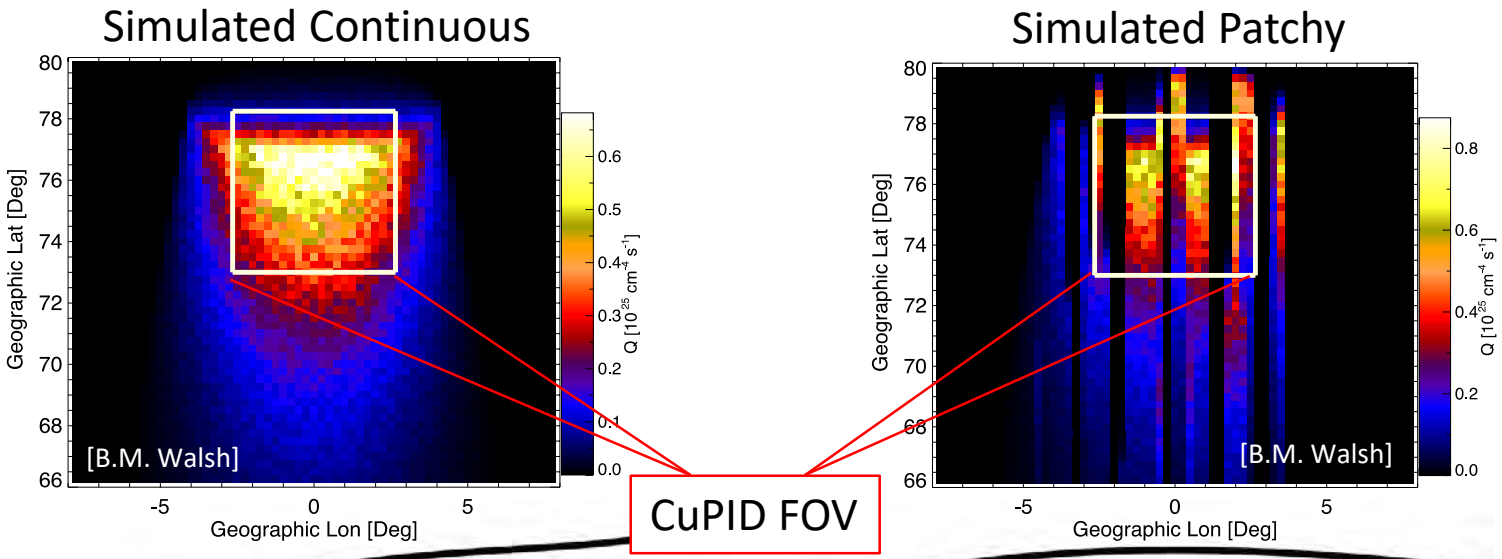
Solar wind charge-exchange (SWCX)

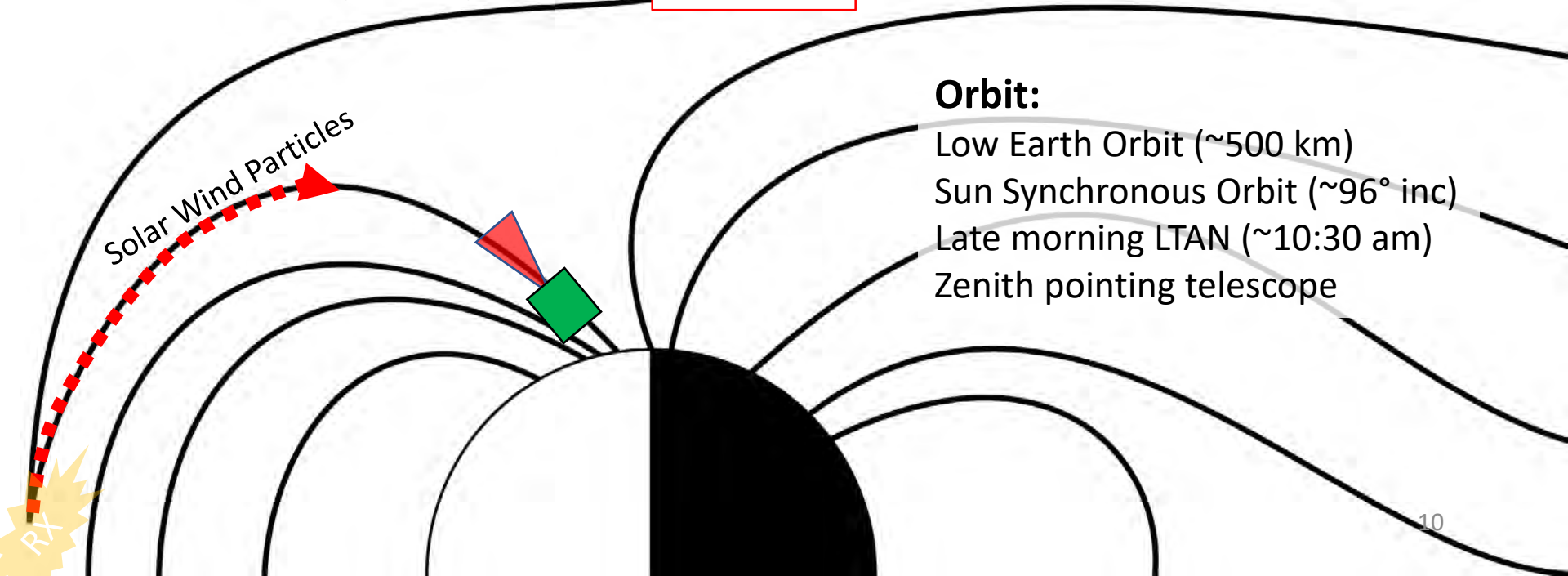
Example Interactions

$$O^{+7} + H = O^{+6*} + H^{+} + \text{Soft X-ray}$$ 0.1-2keV

[Walsh, et. al, 2016]

The CuPID Mission will fly an X-ray observer through the magnetospheric cusps to image SWCX.





Orbit:

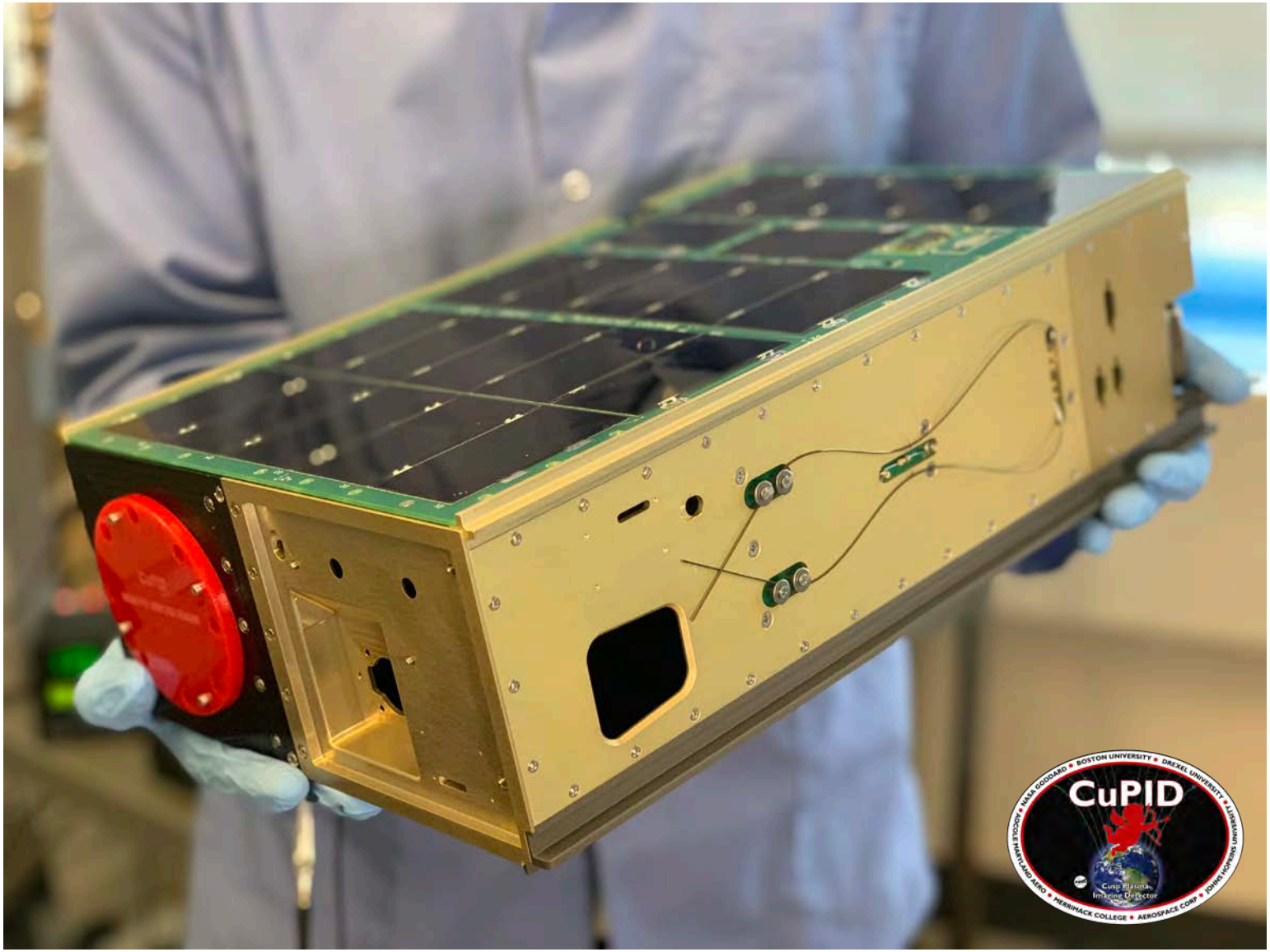
Low Earth Orbit (~500 km)

Sun Synchronous Orbit (~96° inc)

Late morning LTAN (~10:30 am)

Zenith pointing telescope

The CuPID Cubesat, built at Boston University and Goddard Space Flight Center, is set to launch December 2020!



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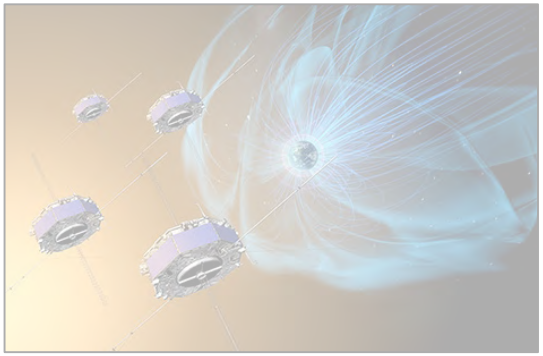

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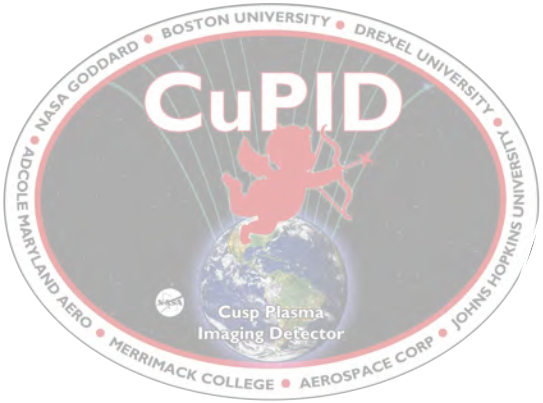

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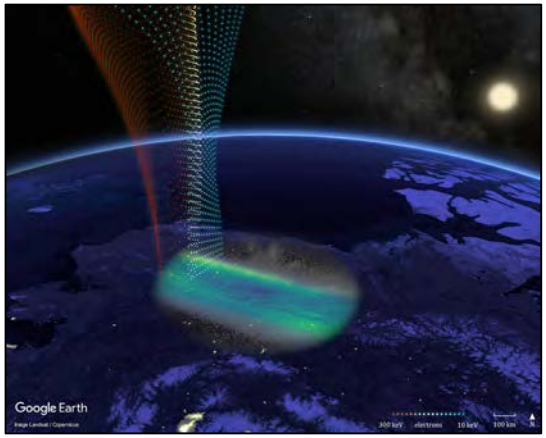
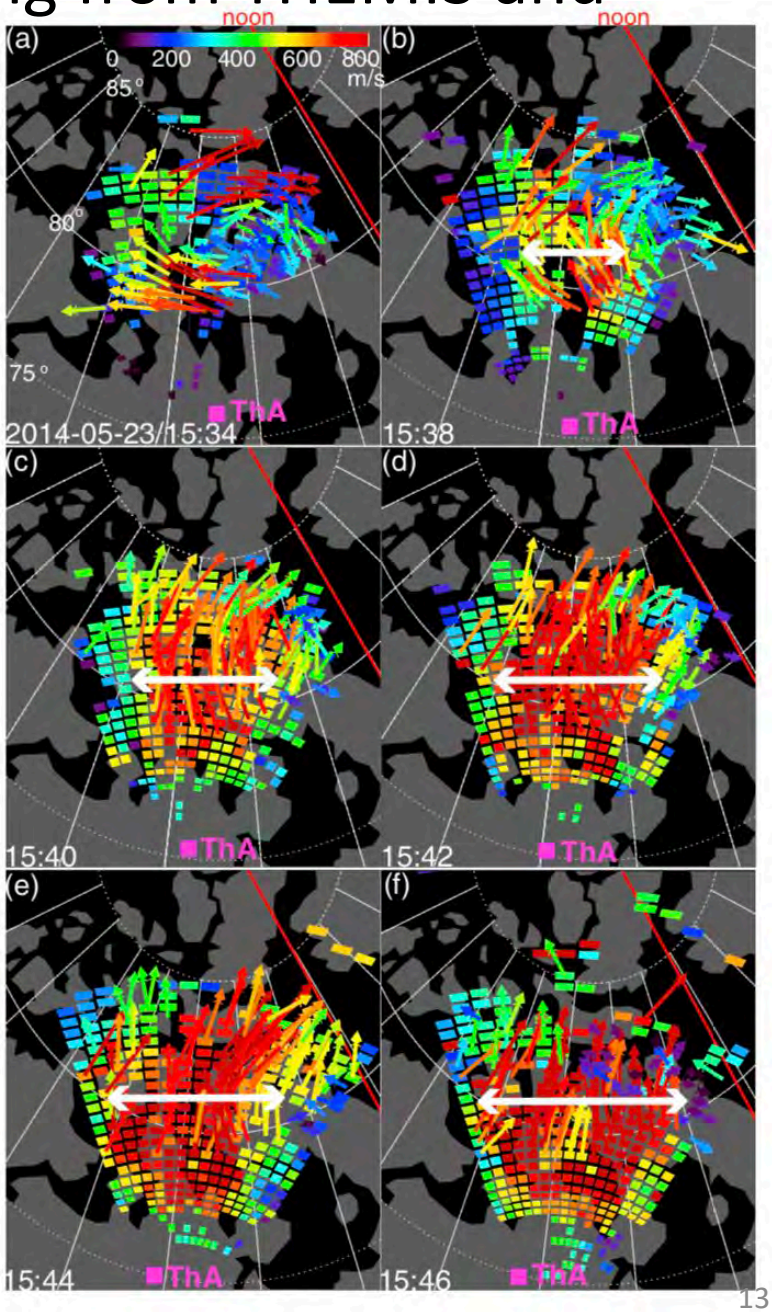


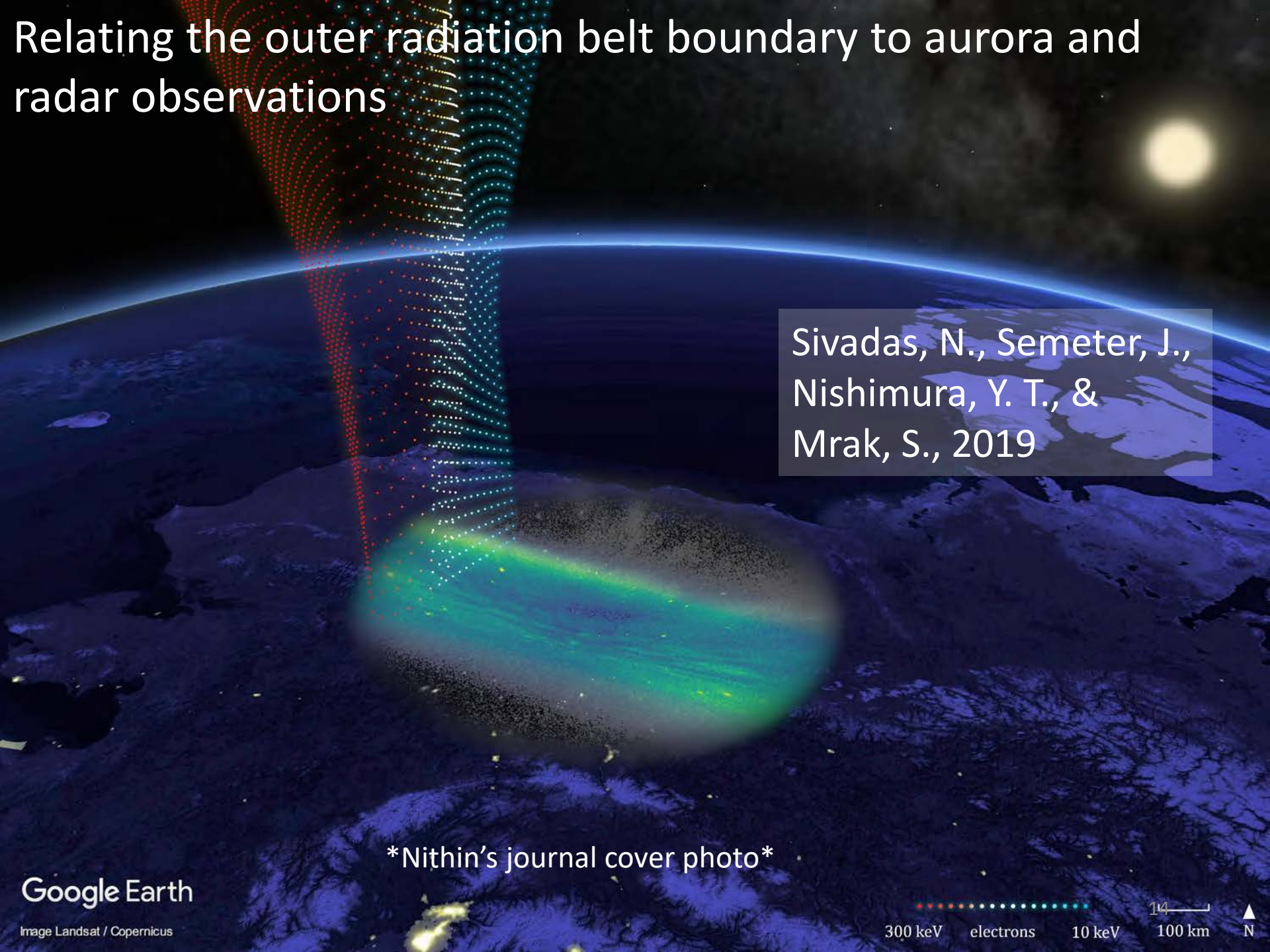
Observing reconnection spreading from THEMIS and SuperDARN conjunctions

Ying Zou et. al, 2017

- **Radar:** Observing the change of line of sight (LOS) velocity over time
- **THEMIS:** Observed Rx jet at magnetopause



Relating the outer radiation belt boundary to aurora and radar observations



Opportunities for interesting science, collaborations are welcome!