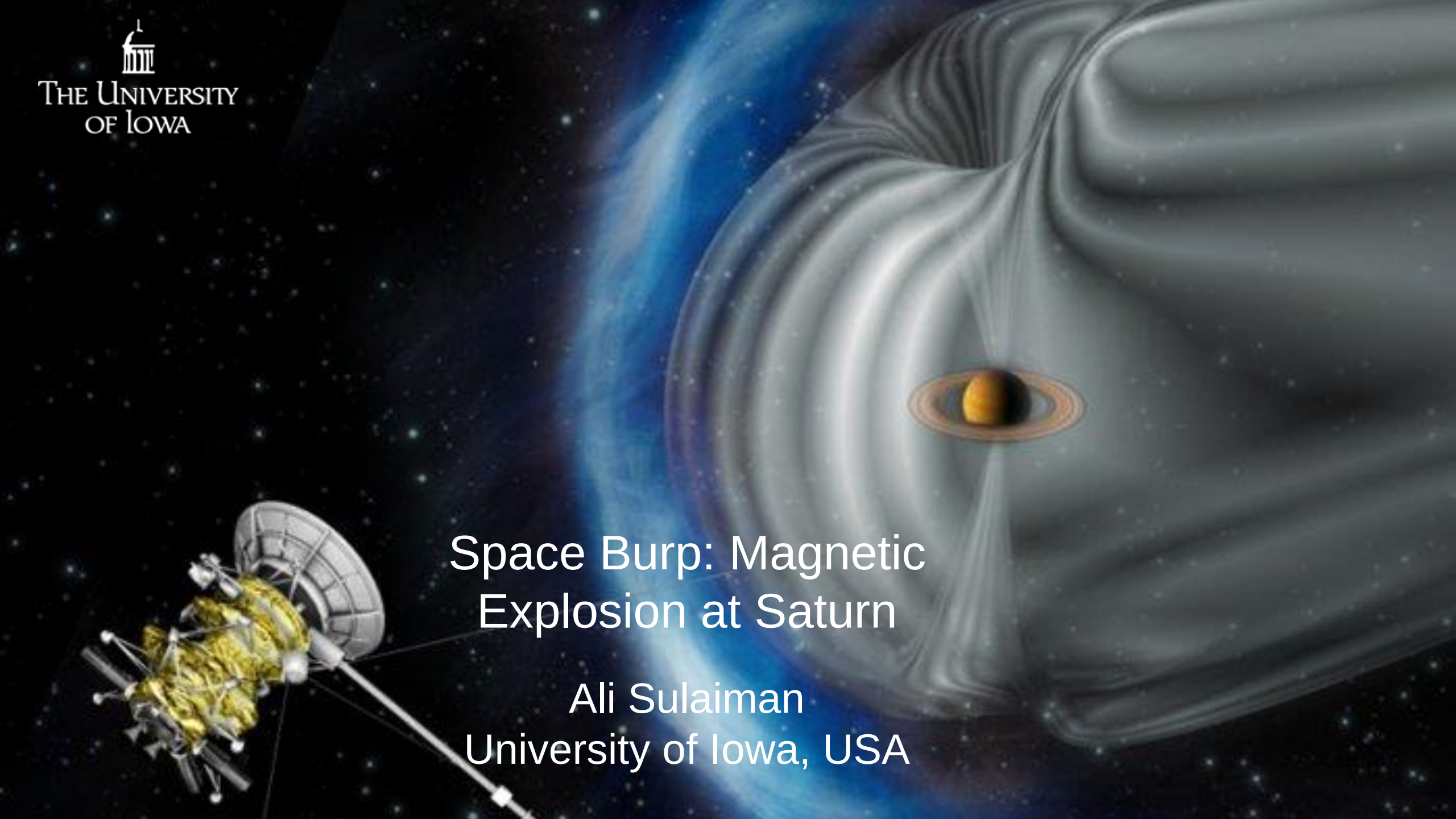
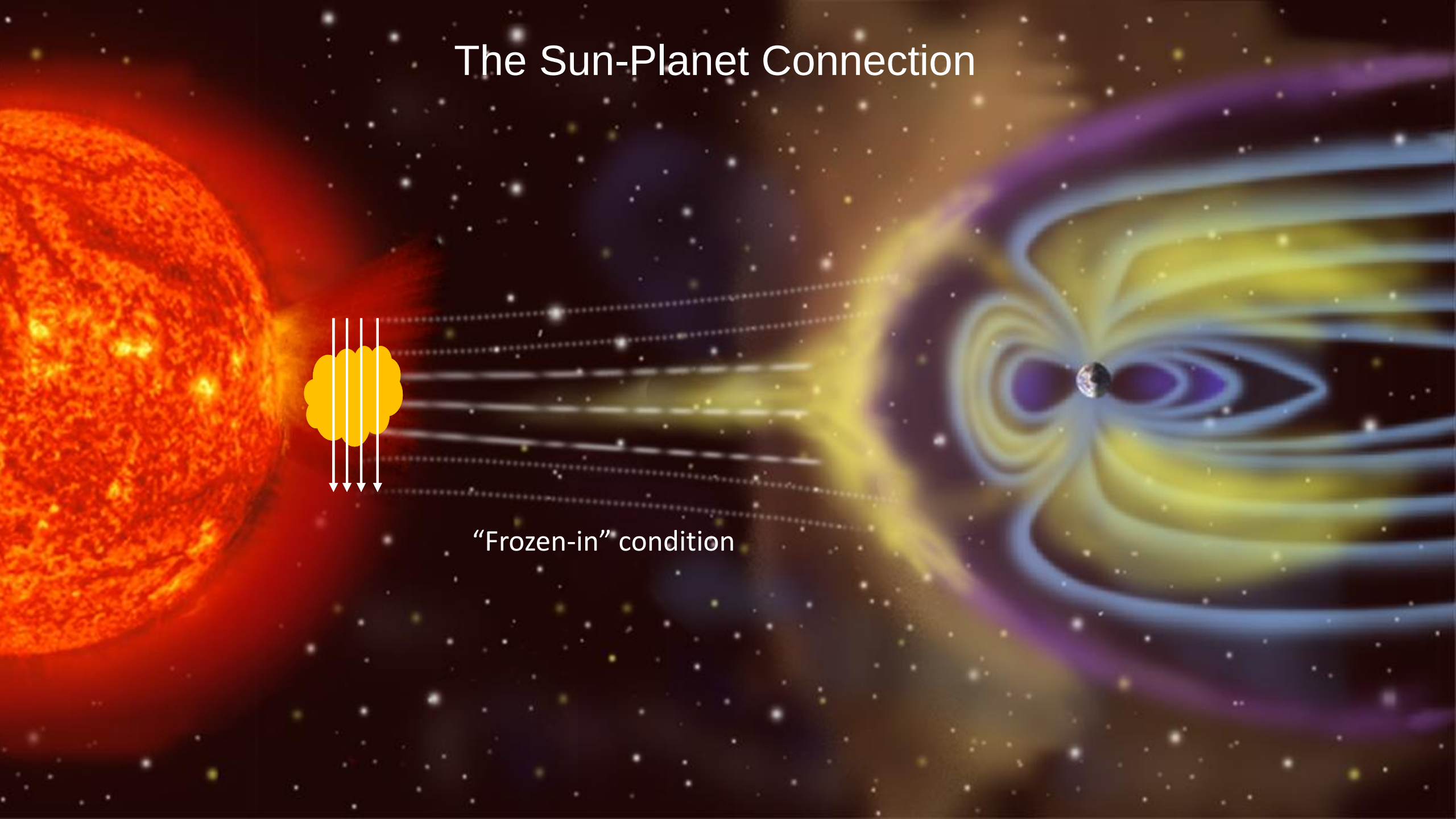


Space Burp: Magnetic Explosion at Saturn

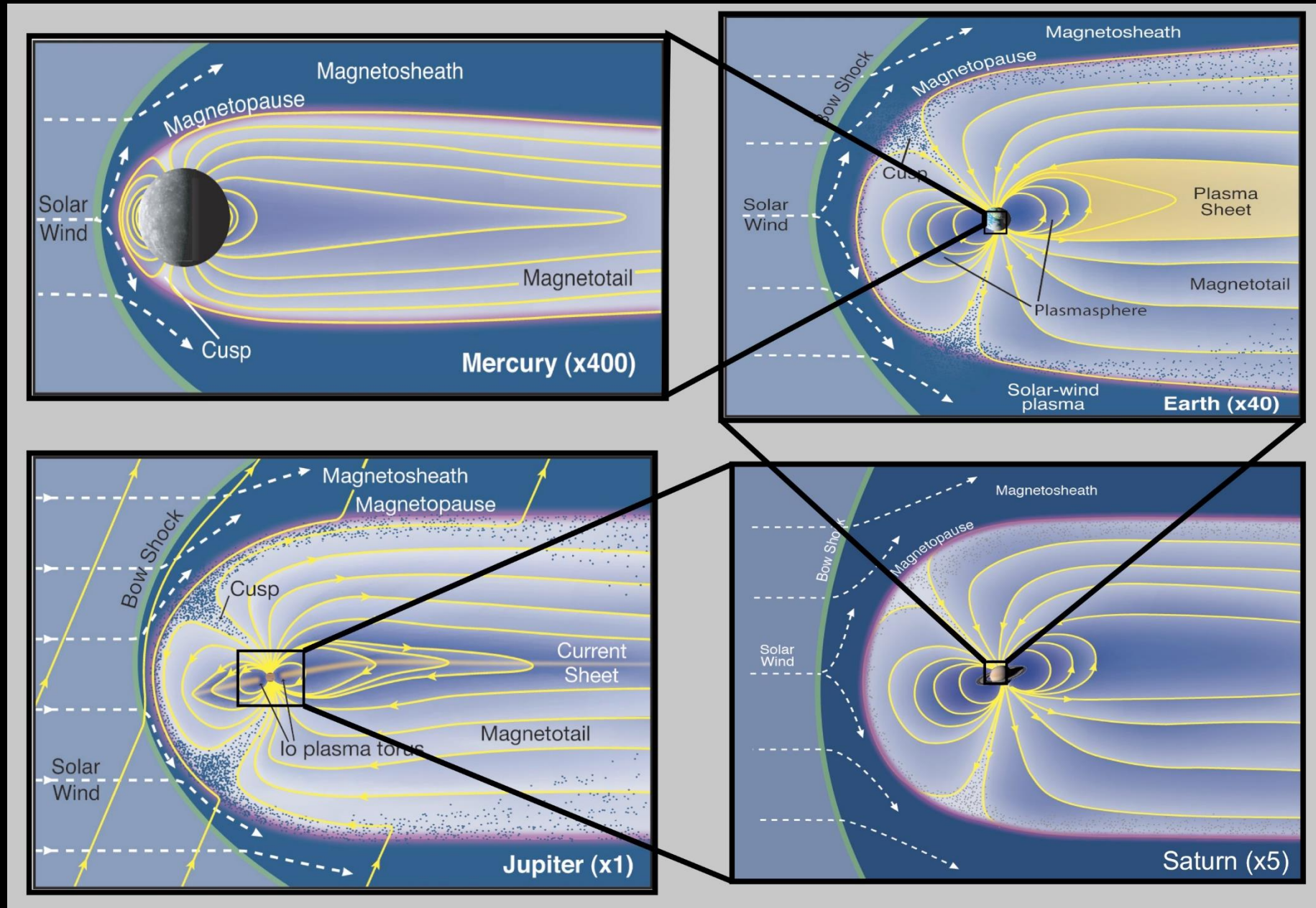
Ali Sulaiman
University of Iowa, USA

The Sun-Planet Connection



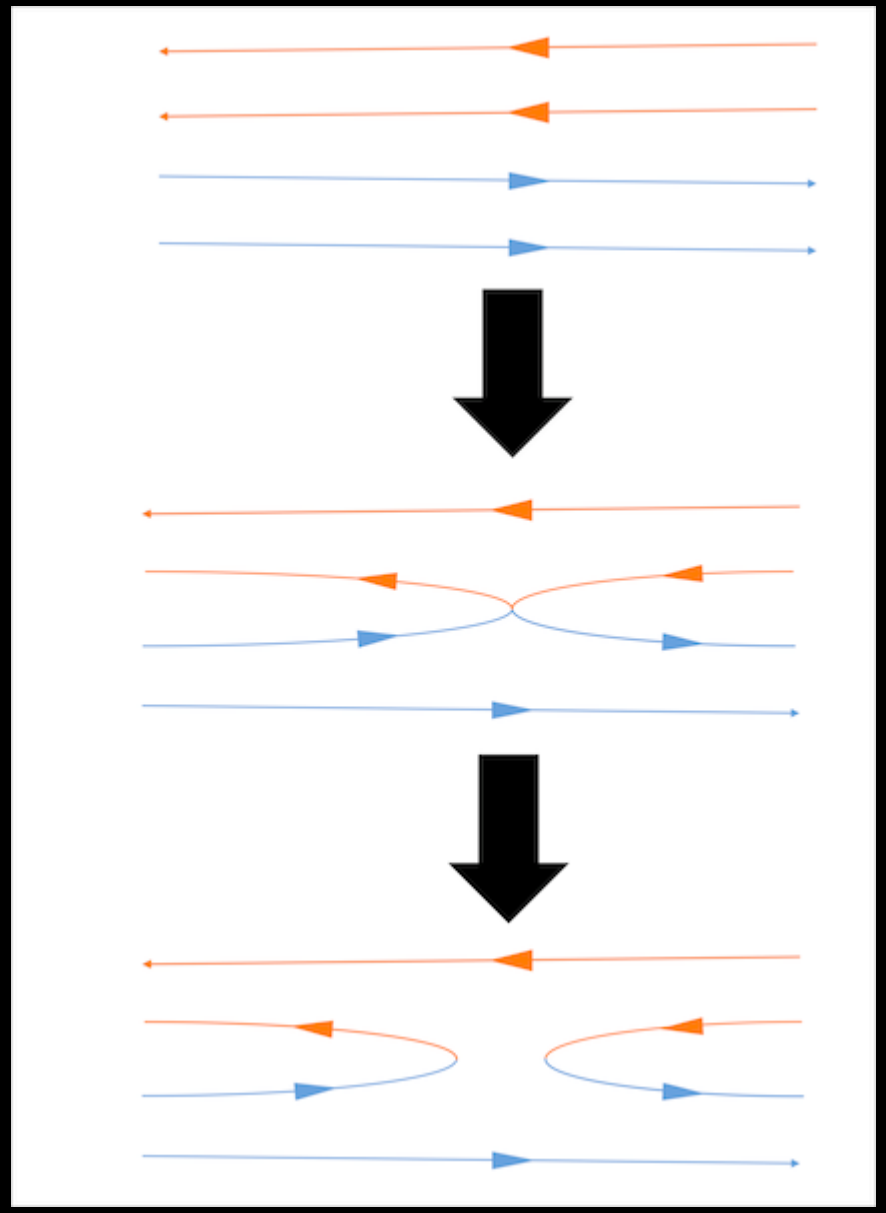
"Frozen-in" condition

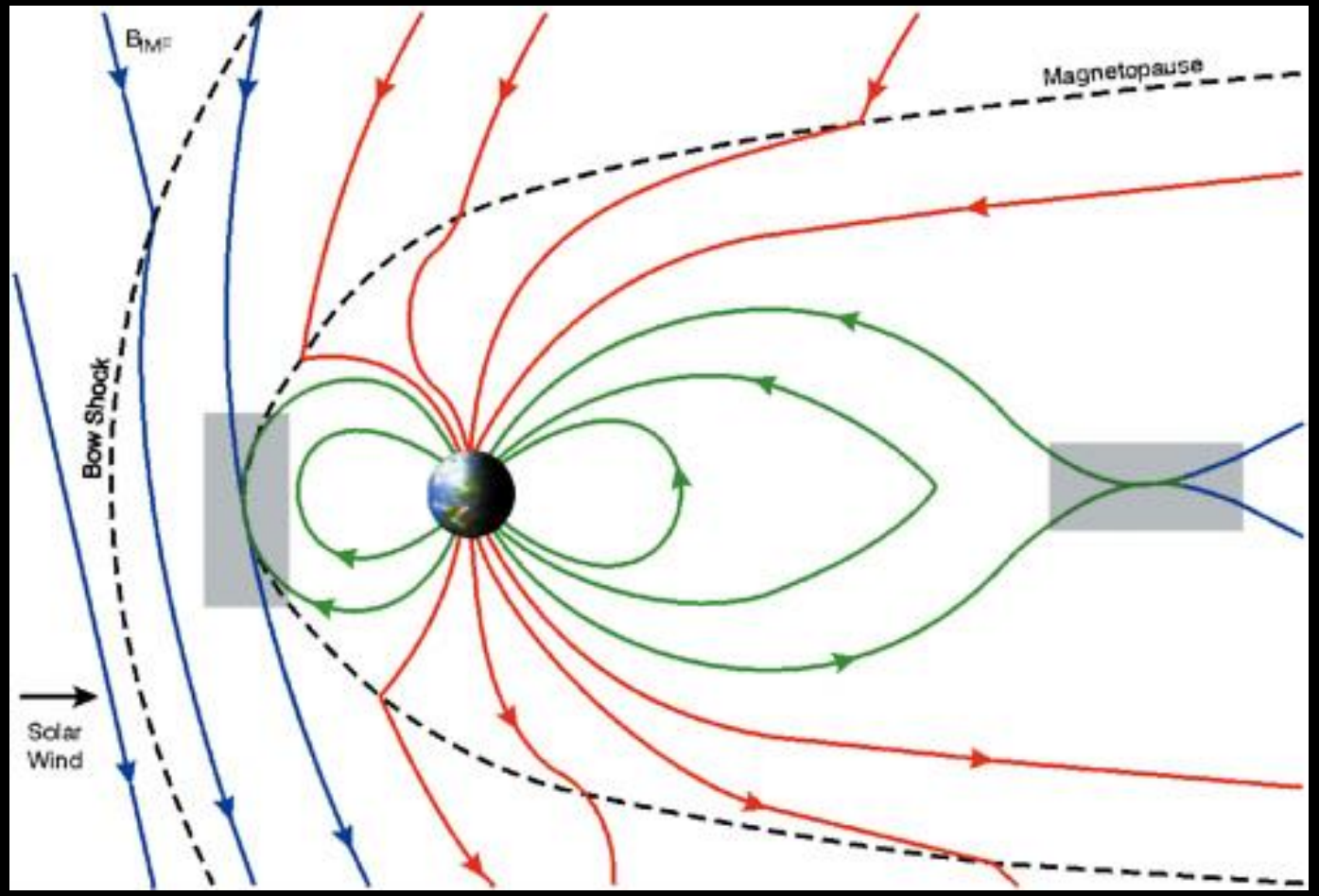
What controls the shape and size of a magnetosphere?



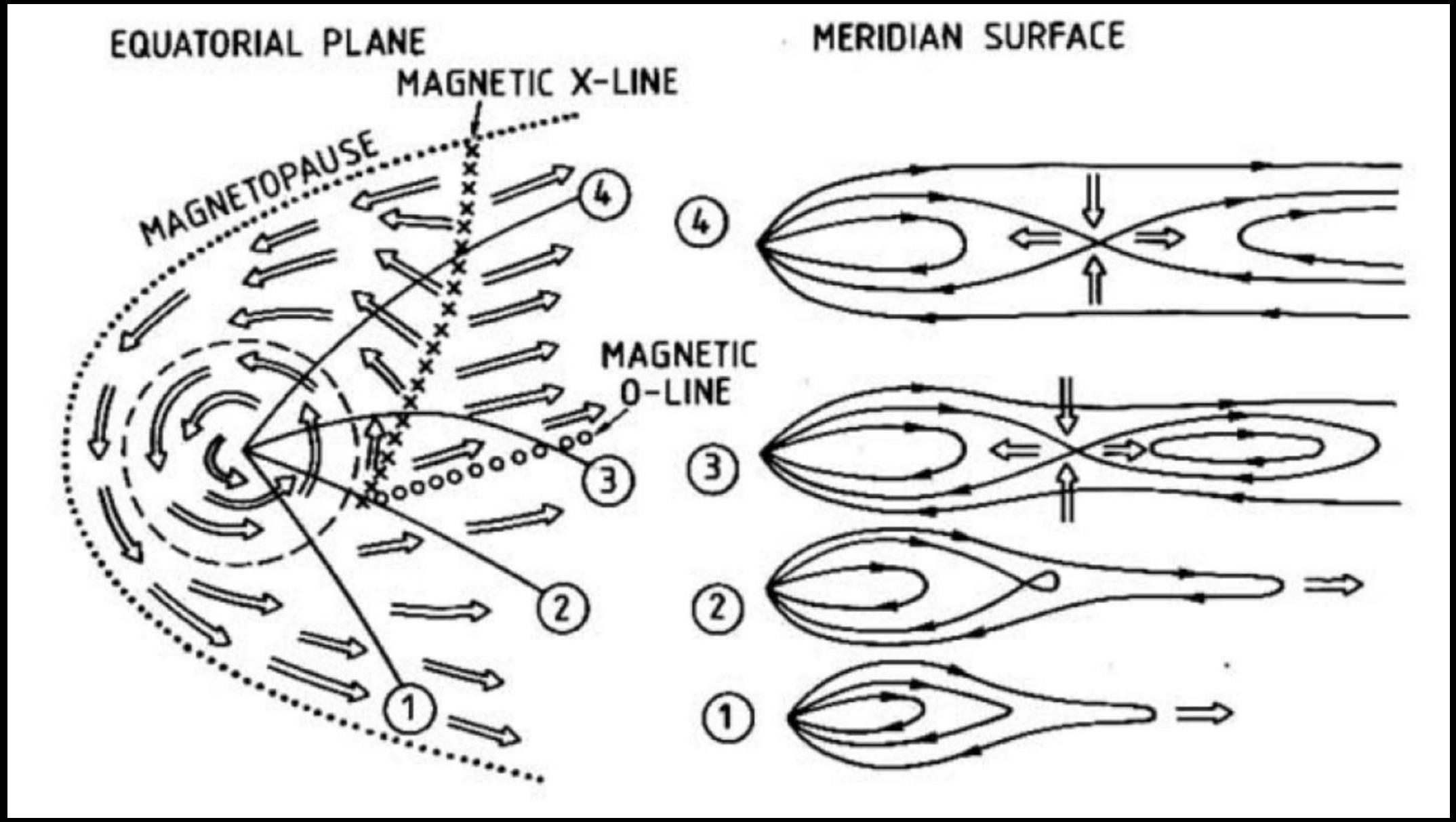
Credit: Bagenal and Bartlett

Magnetic reconnection



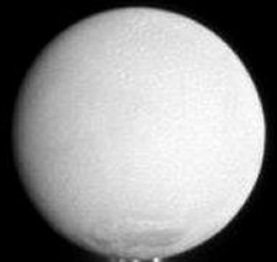


The role of fast rotation in plasma loss



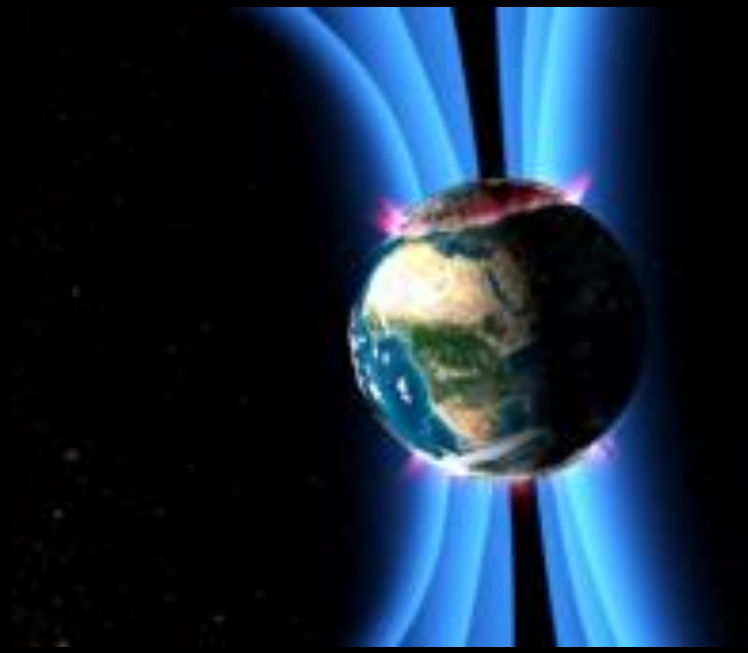
Hill et al. (2008)

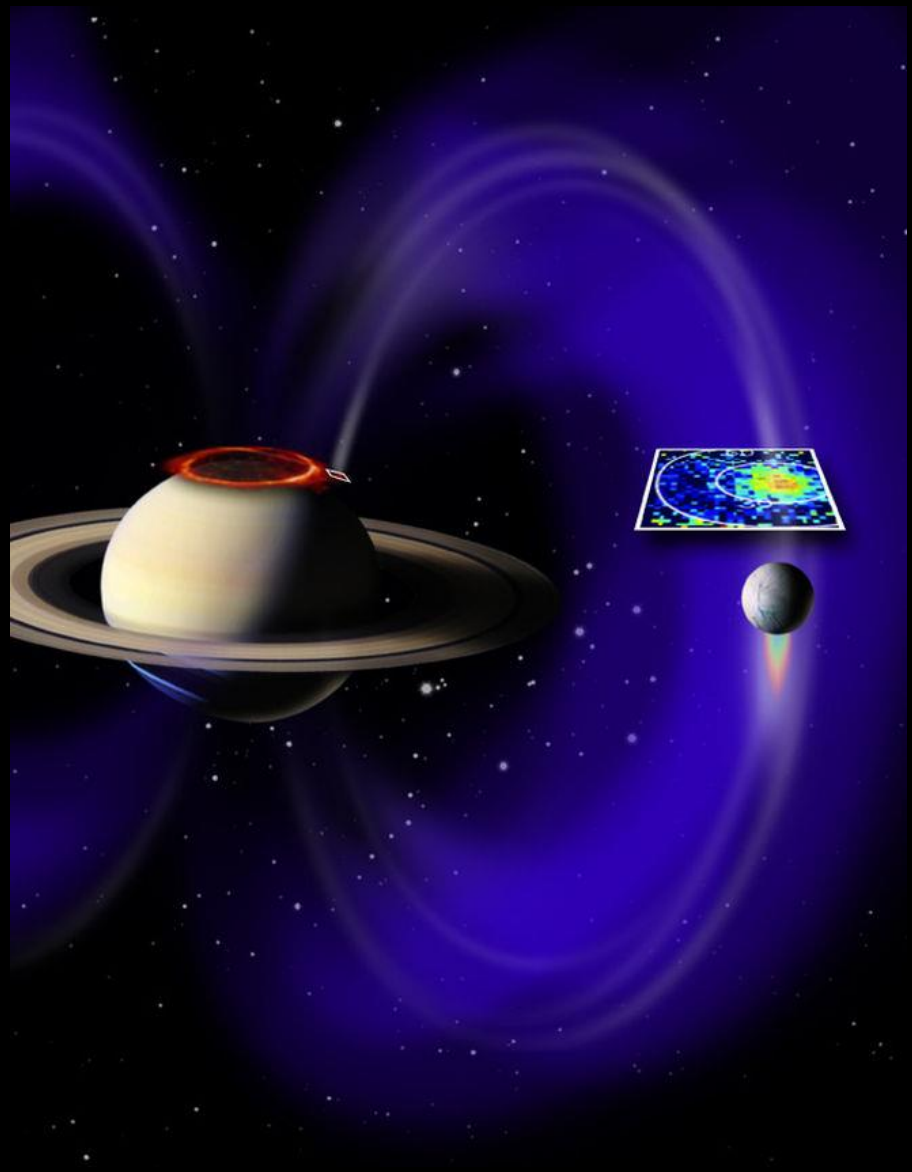
Enceladus: A source of internal plasma



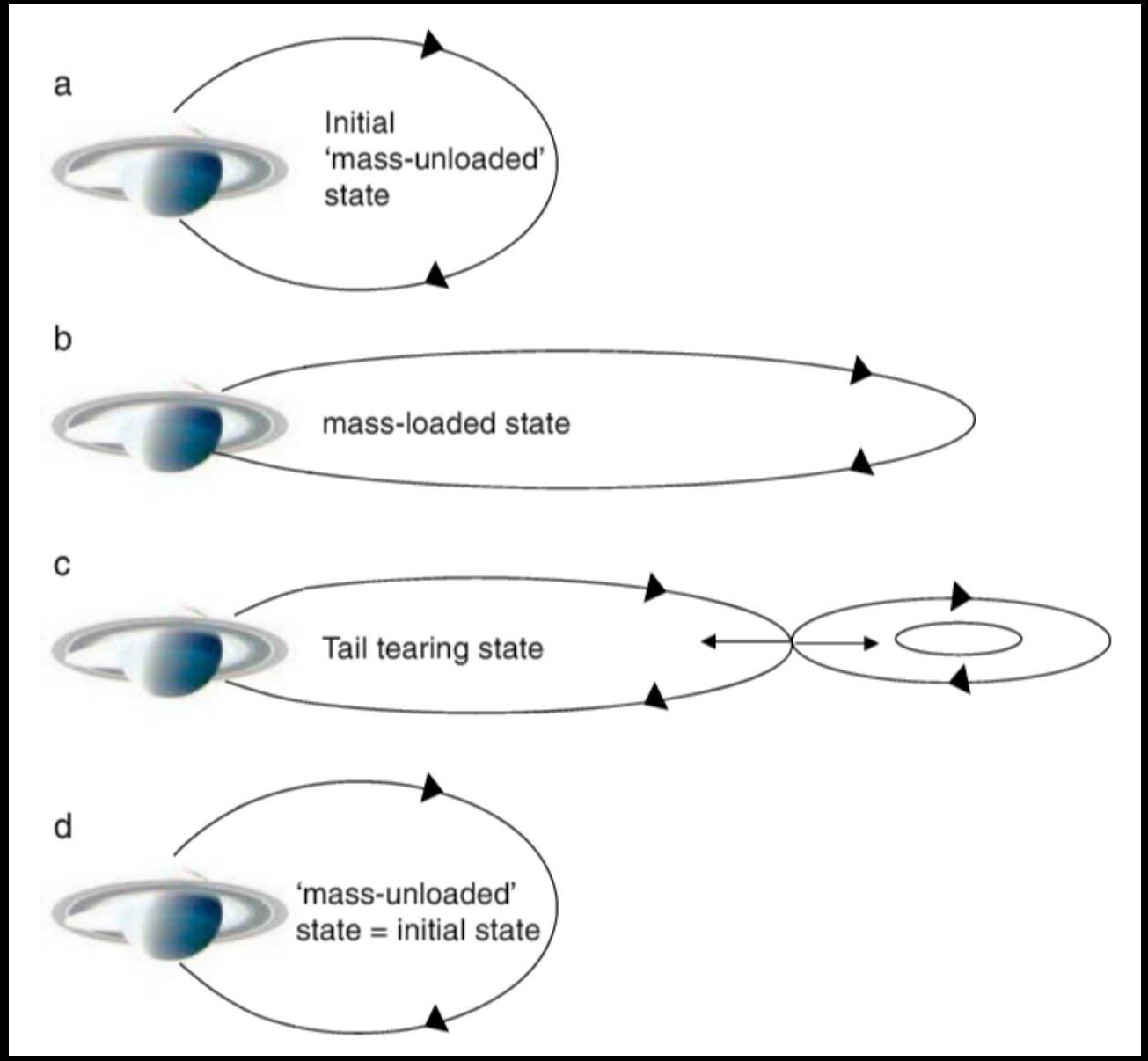
~100 kg of Water group ions per second

Aurora





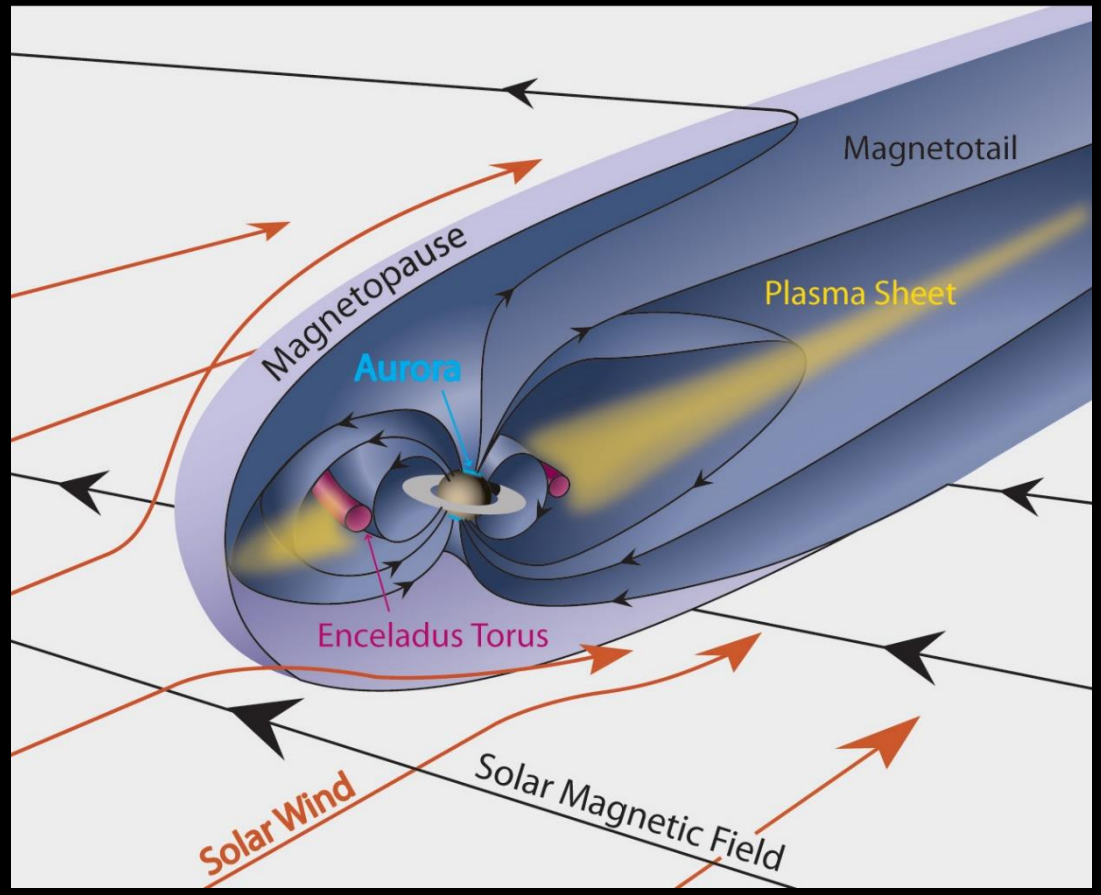
Saturn's Refresh Rate



Rymer et al. (2013)

The conditions at Saturn

Plasma Source		Plasma Loss	
Dayside (Dungey) reconnection	?	Nightside (Dungey) reconnection	?
Moon	✓	Nightside (Vasyliunas) reconnection	?



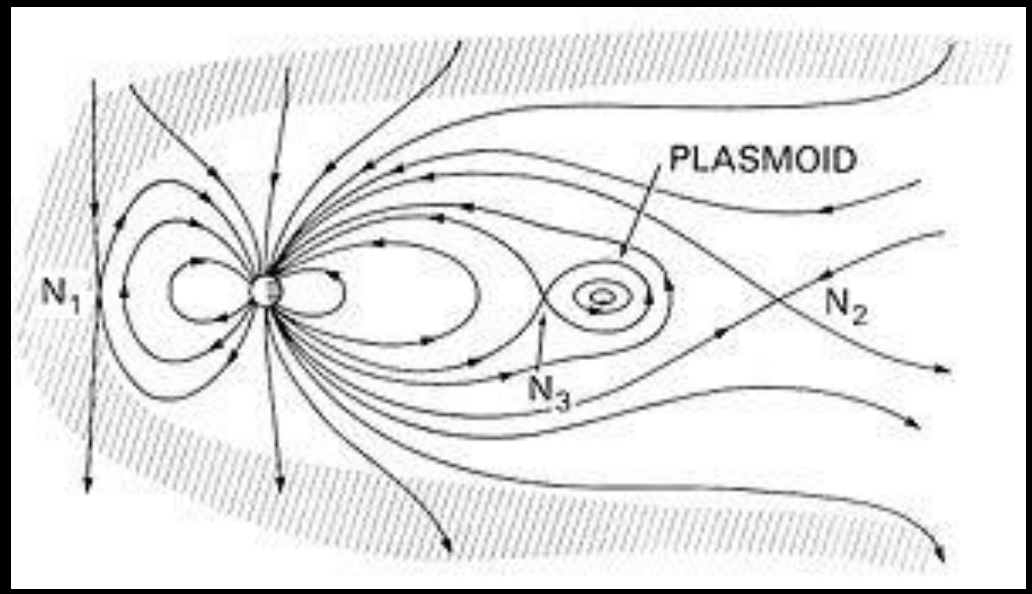
Credit: Bagenal and Bartlett

Mass loading vs loss

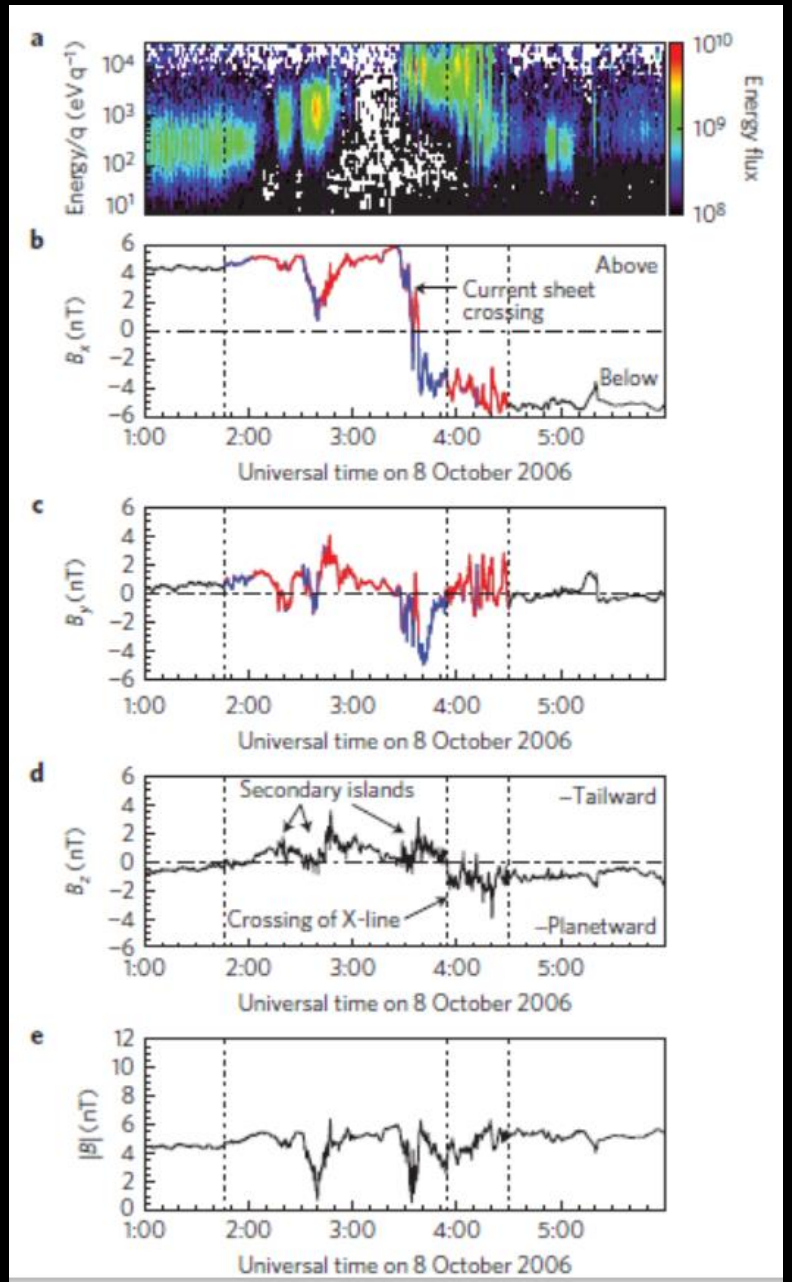
- Enceladus deposits **+100 kg/s** of plasmas
- This is continuous

- A plasmoid has a typical volume of 10 cubic Saturn radii
- Each plasmoid ejects **-62 × 10^3 kg**
- This amounts to **~200 plasmoids/day** (every ~7 minutes) required to eject all of Enceladus' plasmas

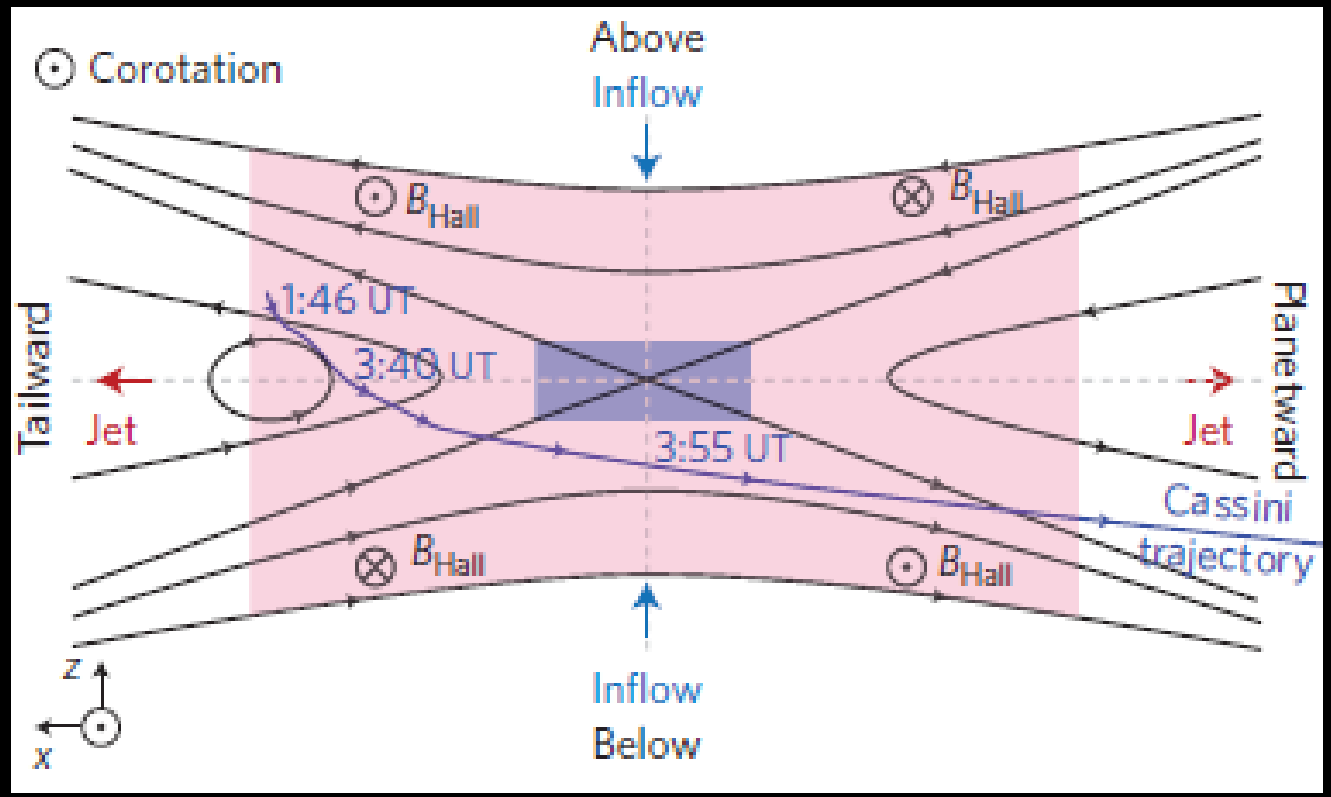
- It was thought nightside reconnection is not frequent enough to sufficiently shed all the loaded mass.
- Other magnetospheric mechanism proposed to contribute to the mass loss



Microphysics of reconnection:
First detection of the diffusion region at Saturn



- Mass of proton = ~ 1800 mass of electron
- Protons become demagnetized first.. then electrons
- The consequence → Hall fields



Arridge et al. (2016)

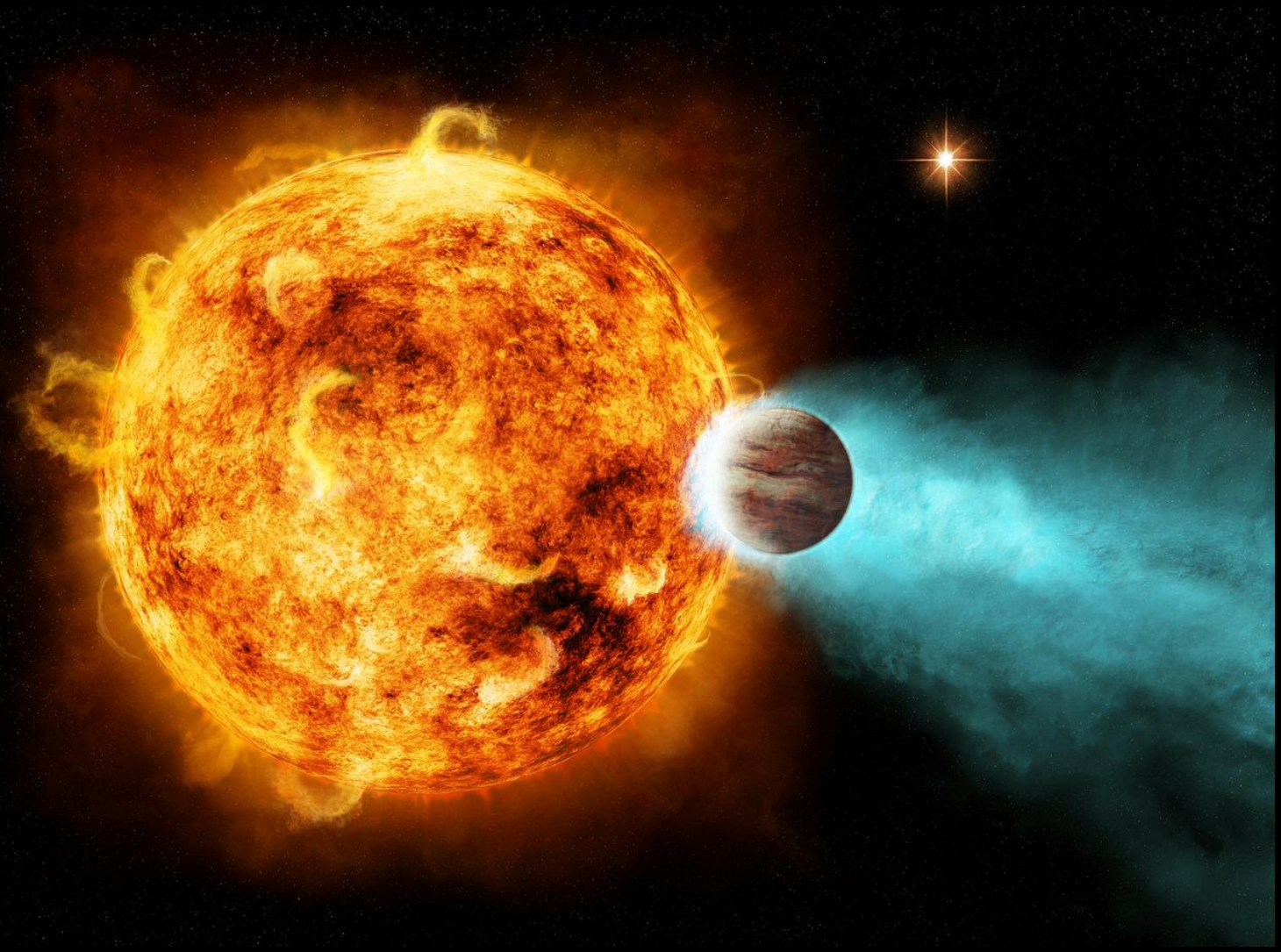
Long duration magnetic reconnection

- Reconnection lasted for 19h (approx. two rotations of Saturn)
- The estimated mass loss from this was **-3×10^7 kg**
- This is 3 orders of magnitude (~1000 times) more than previously estimated

- An event as such every 4-40 days is required to shed all of Enceladus' plasma instead of every 7 minutes
- Hence magnetotail reconnection can act as a very significant loss mechanism in a fast rotating planet

Much wider implications

- Over 300 hot Jupiter-like planets discovered
- We not have a better understanding of how these systems behave



Summary

- Nightside reconnection can be explosive at Saturn
- The ejected plasma has been estimated to be enormous and can provide the required mass loss to balance Enceladus' continuous outgassing
- A new and important result for fast-rotating magnetospheres as well as reconnection physics