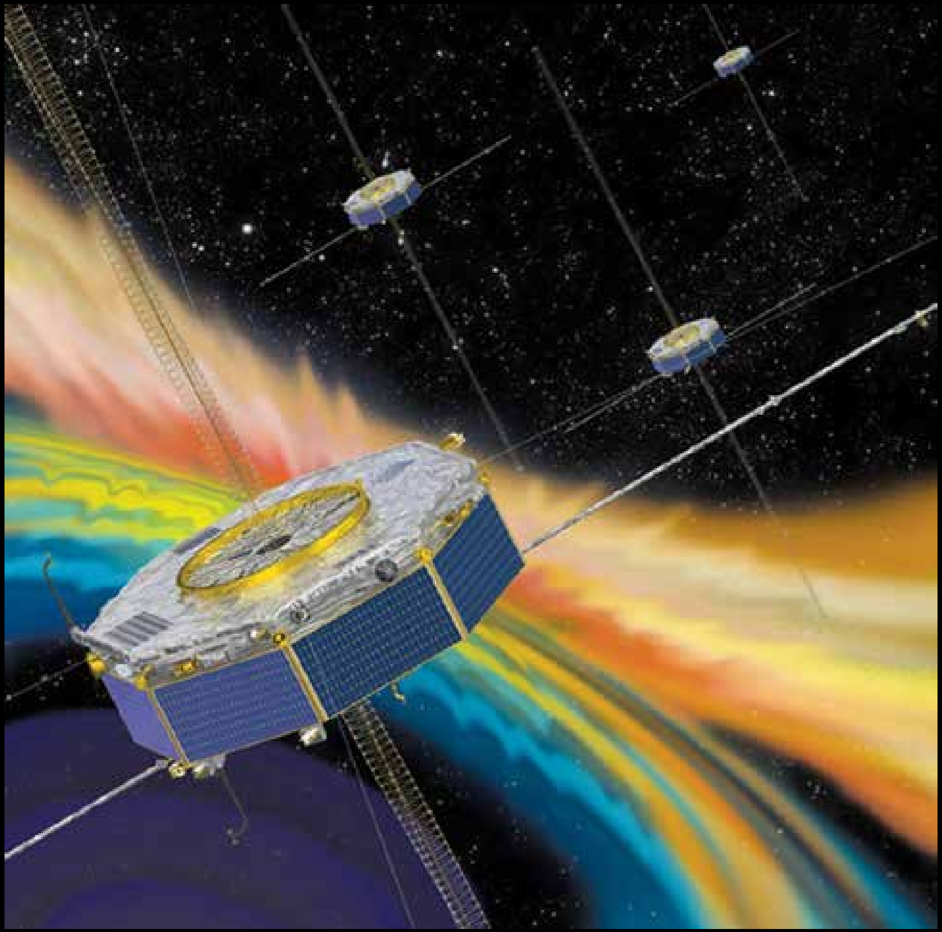
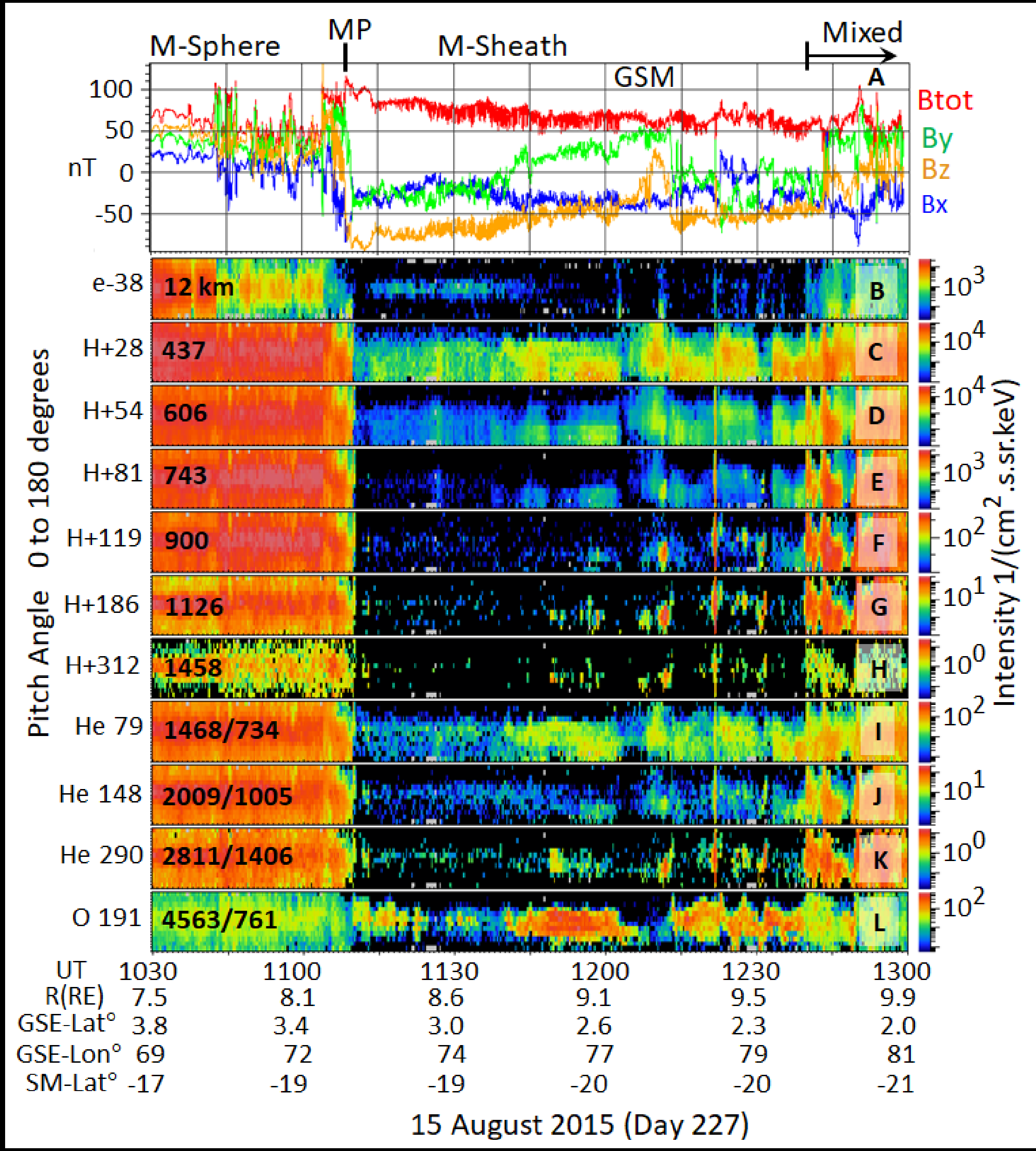
# Investigation of mass/species-dependent escape of energy ions across the magnetopauses of Earth and Jupiter

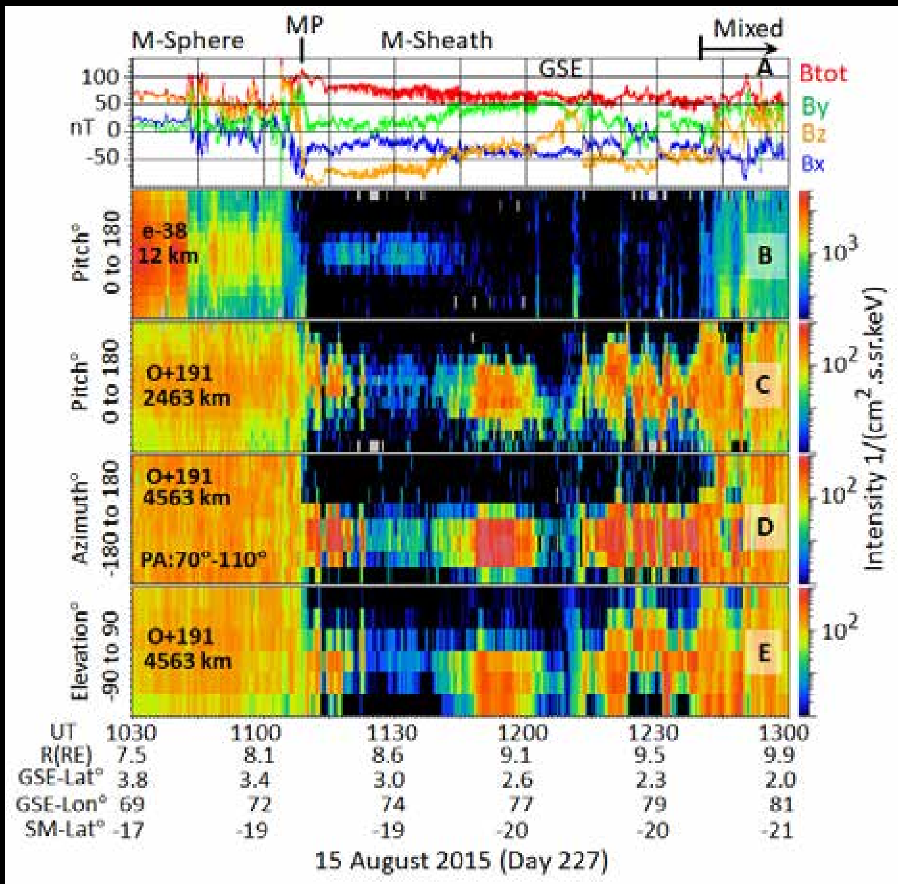
Authors: Barry H. Mauk, et al.

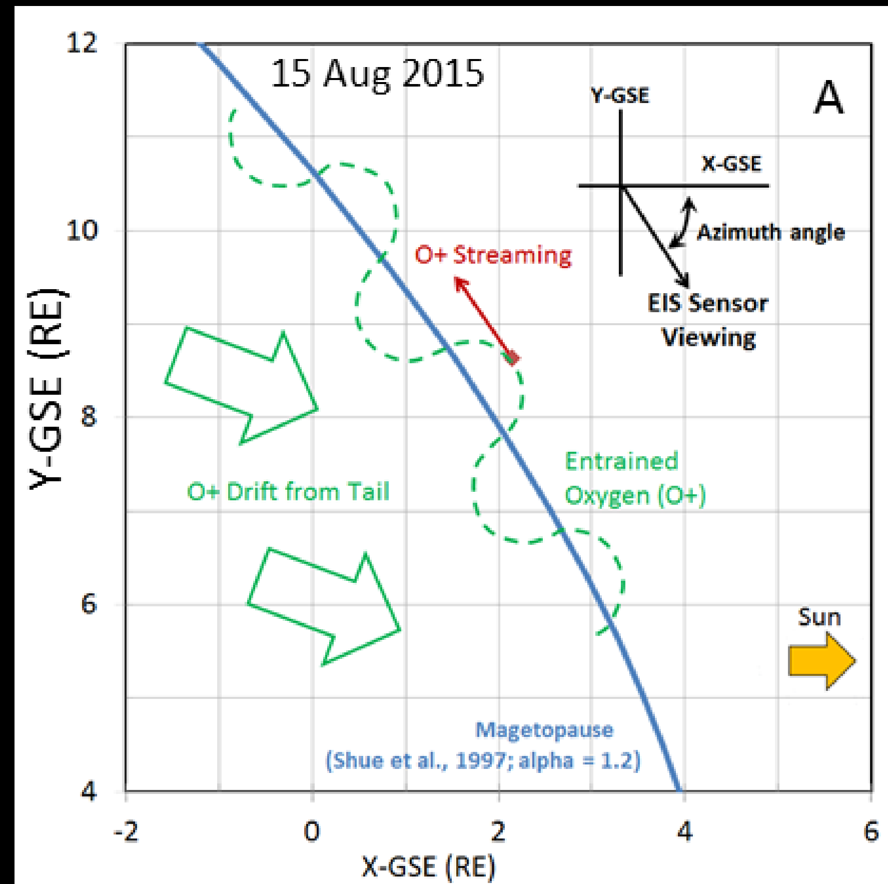


# Magnetospheric Energetic Particle Behavior within the Magnetosheath is roughly ordered by gryro-radius

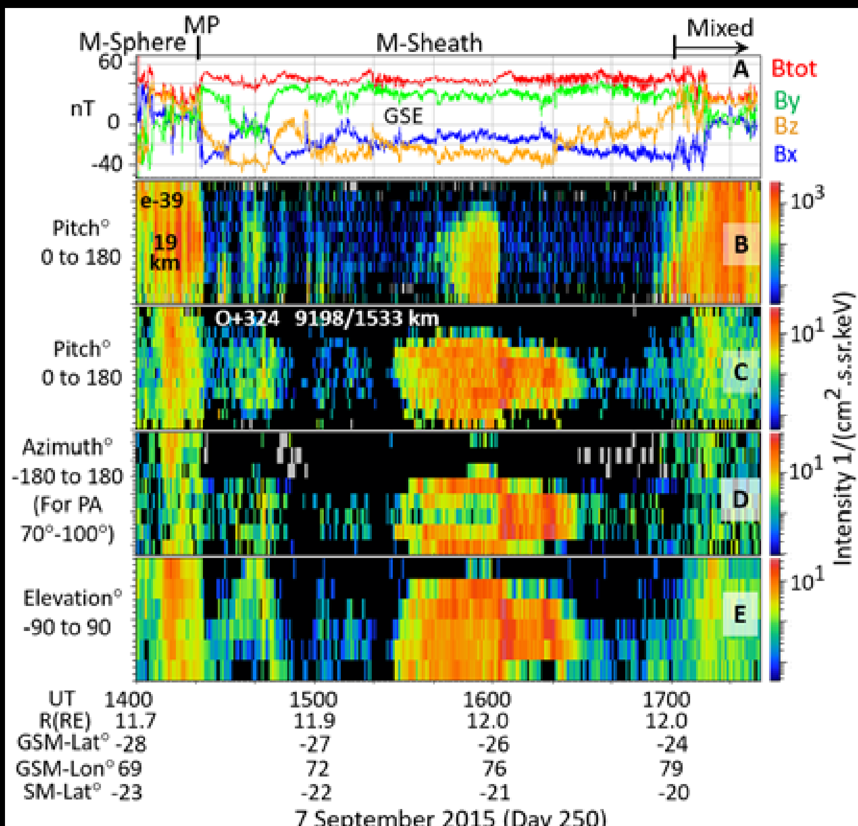


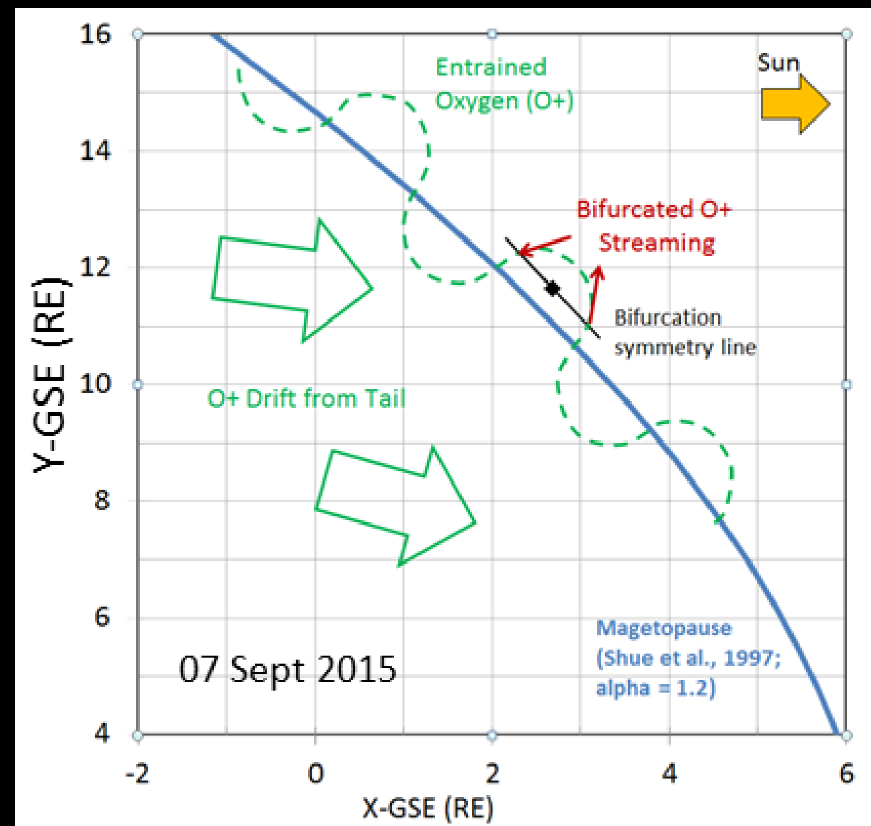
# A detailed look at O+ (191 keV)



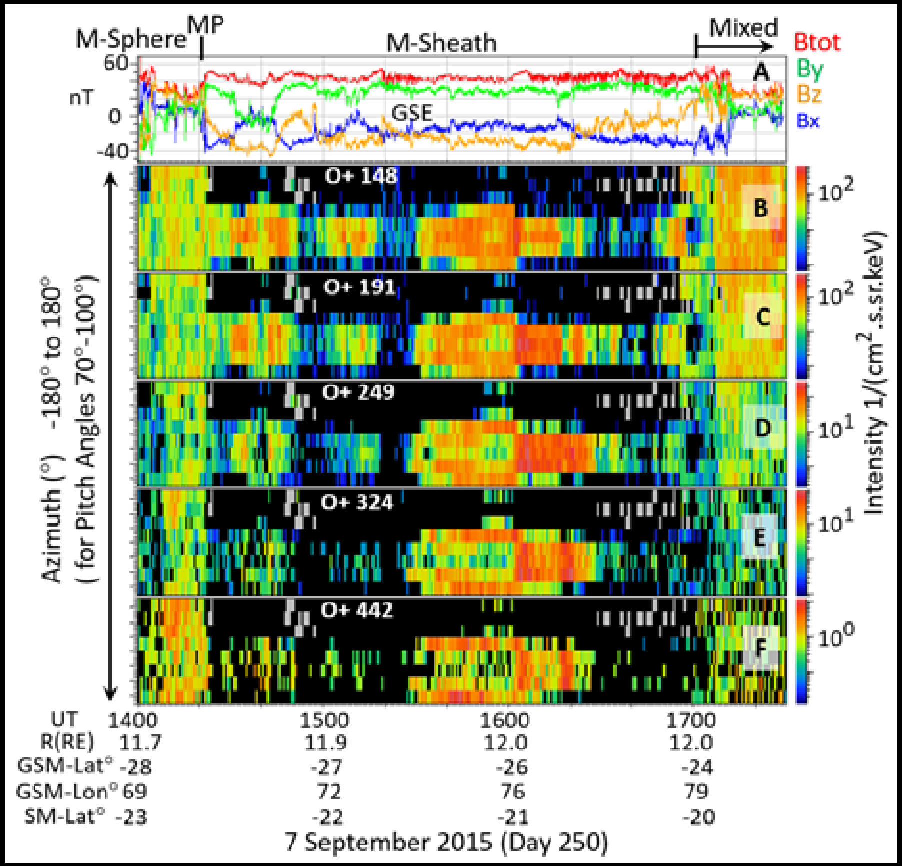
# O+ 324 07Sep16
# Bi-furcation of azimuth distributions



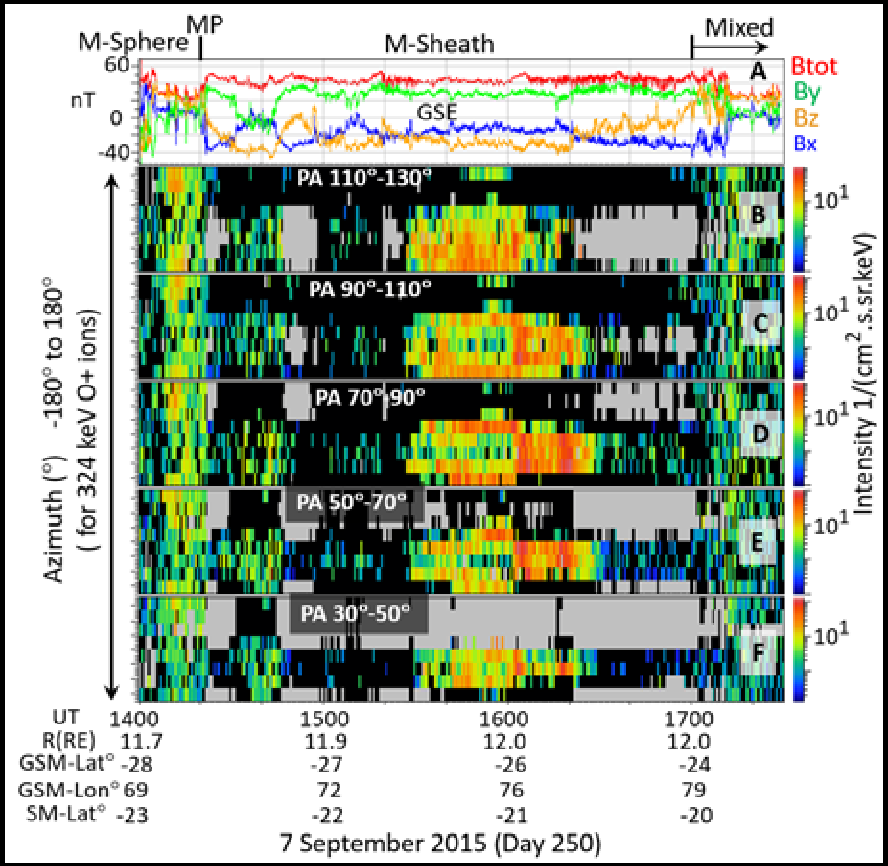



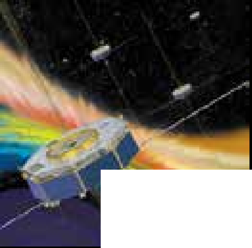
# 07Sep16 O+
# Bifurcation Energy and Pitch Angle dependences

## Energy Dependence

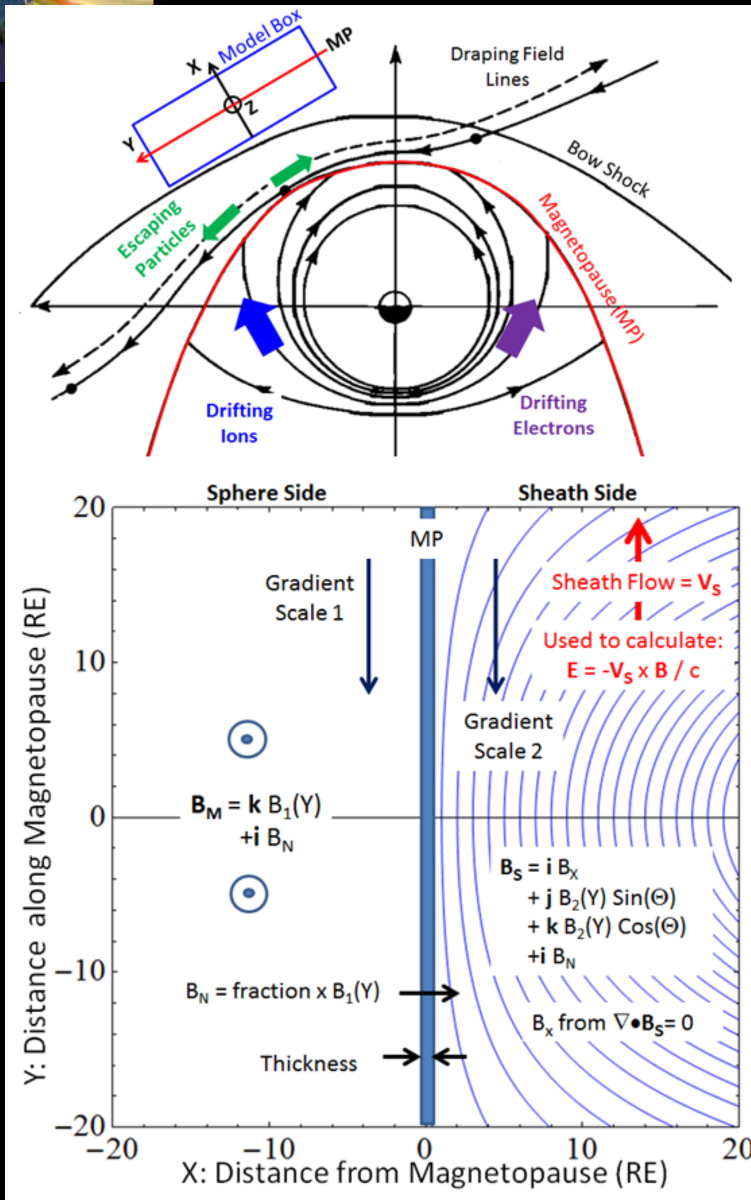


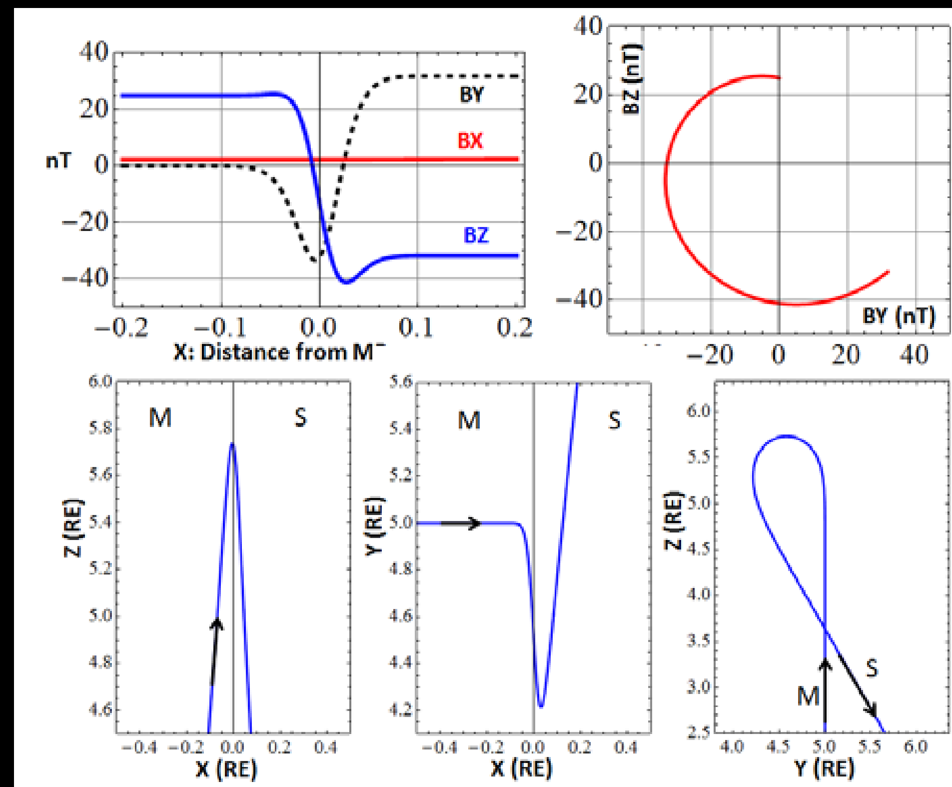

## Pitch Angle Dependence





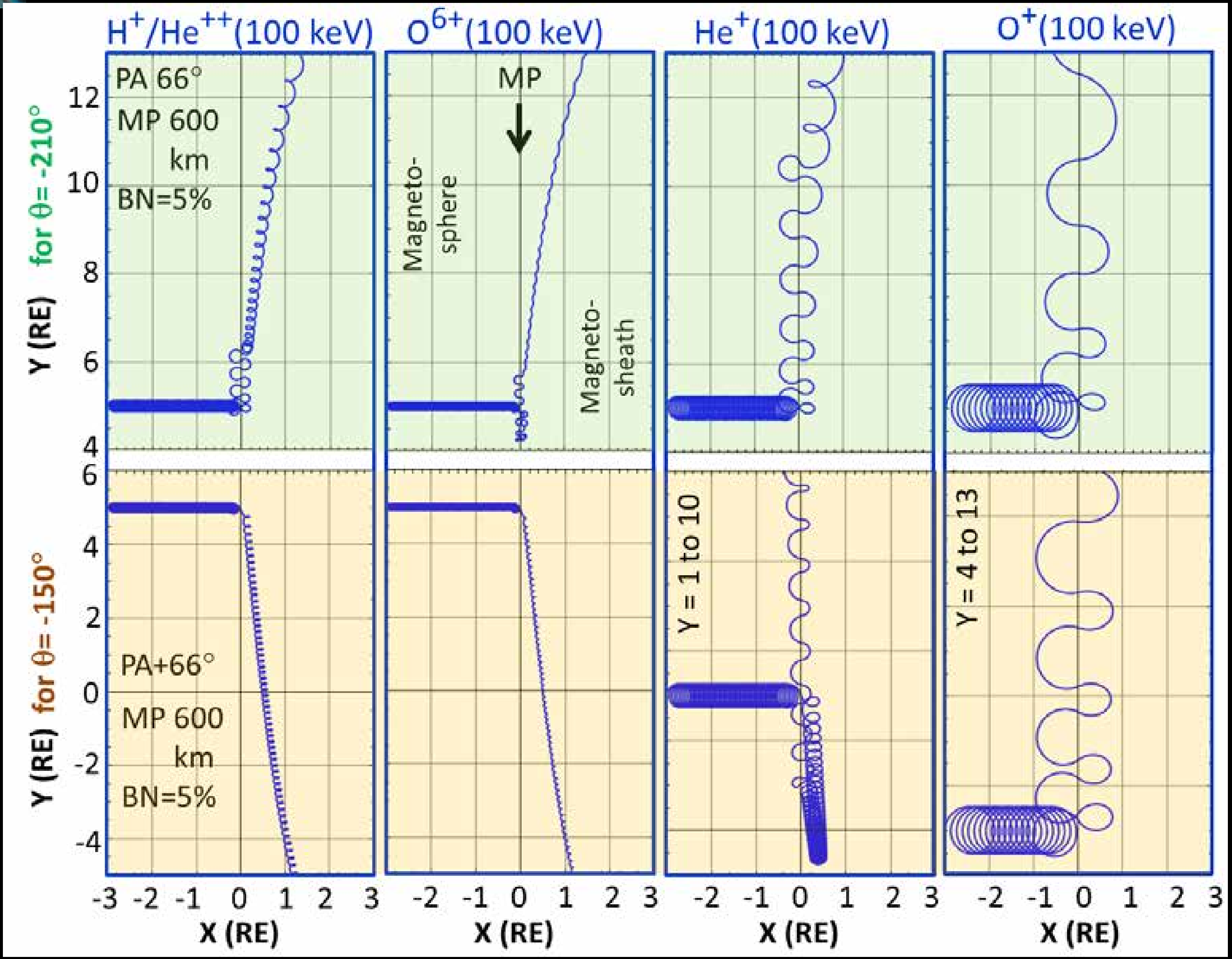
# Modeling of magnetospheric escape




Mauk et al., 2016

# Simple kinetic models show escape is highly mass/charge sensitive



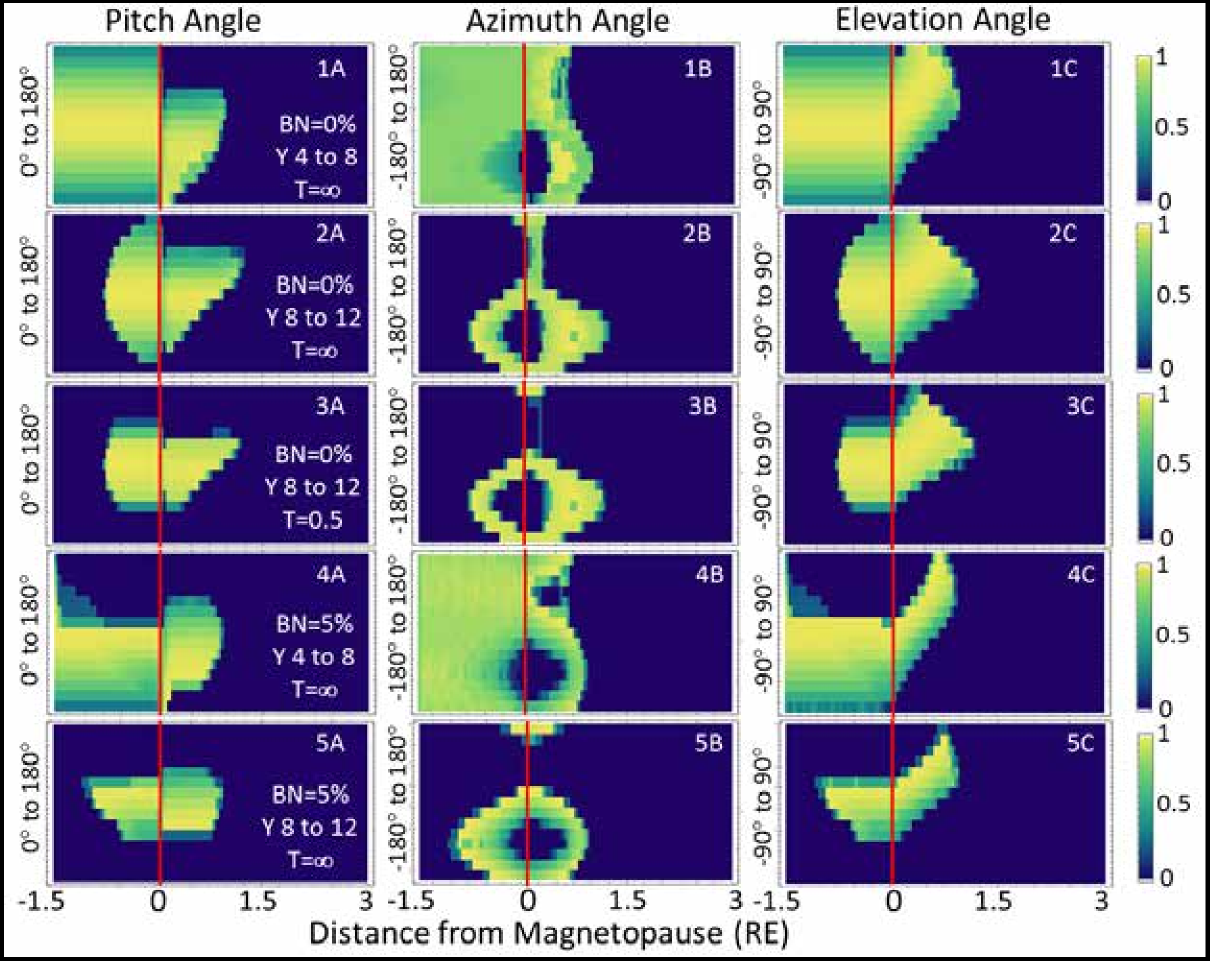
# Intermediary gyro-radii are more likely to escape

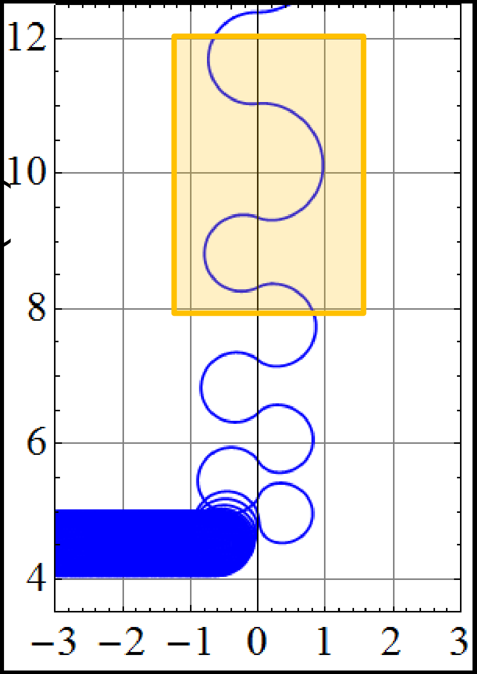
## Modeled probabilities

| Ions 100 keV, MP ~600 km, B1/B2 = 50/70 nT, Launch xyz = (-3, 5, 0) RE | | | | |
|---|---|---|---|---|
| | H+ Escape Probability | | O+ Escape Probability | |
| Theta = | BN = 0 | BN = 5% | BN = 0 | BN = 5% |
| -210° | 0.31 | 0.70 | 0.085 | 0.00 |
| +150° | 0.28 | 0.69 | 0.00 | 0.21 |
| +210° | 0.31 | 0.26 | 0.16 | 0.11 |
| -150° | 0.28 | 0.79 | 0.00 | 0.21 |
| **Average** | **0.29** | **0.71** | **0.061** | **0.13** |

Bi-furcated O+ distributions are fairly easy to generate through modeling

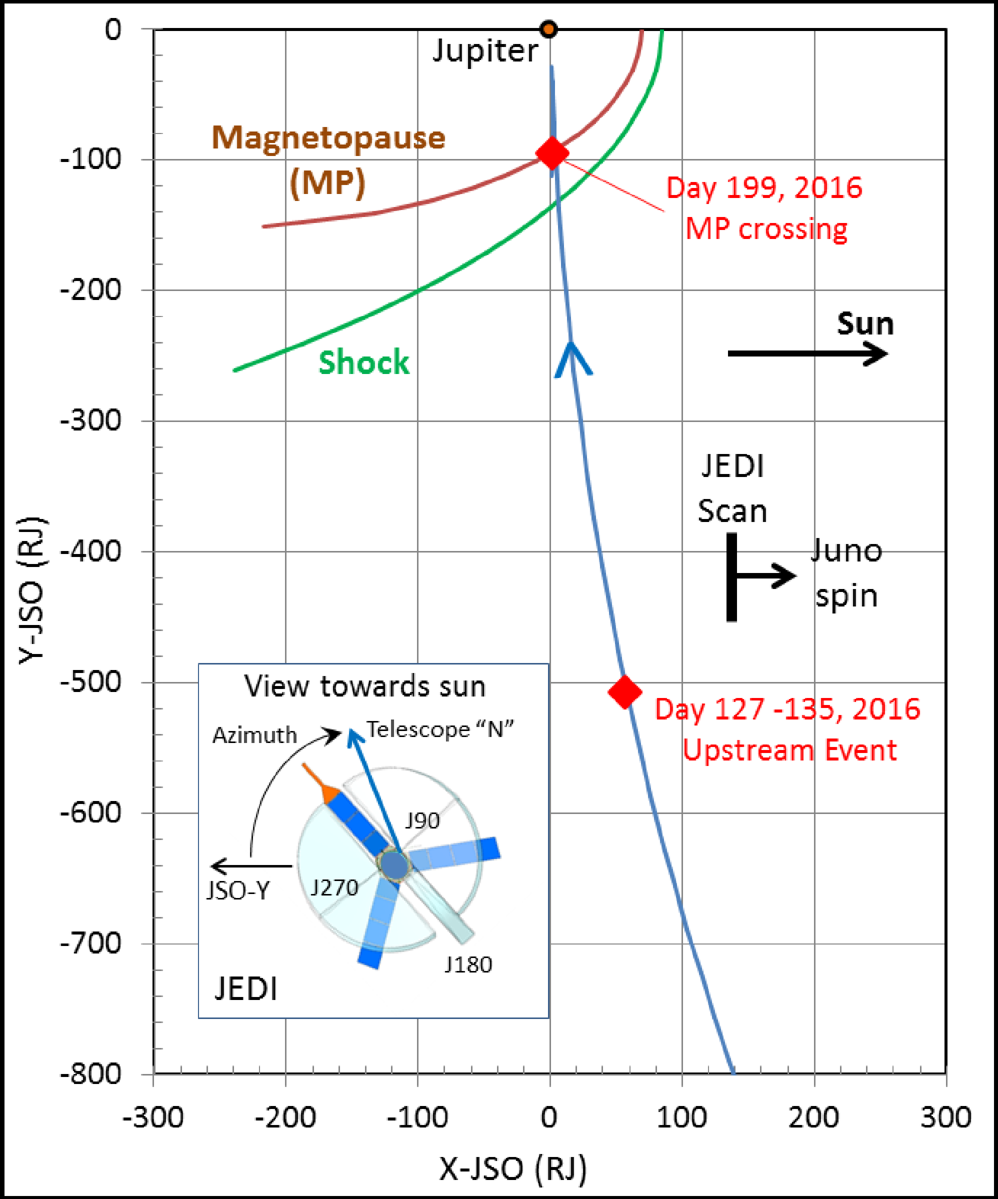
Here are 5 different modeled experiments



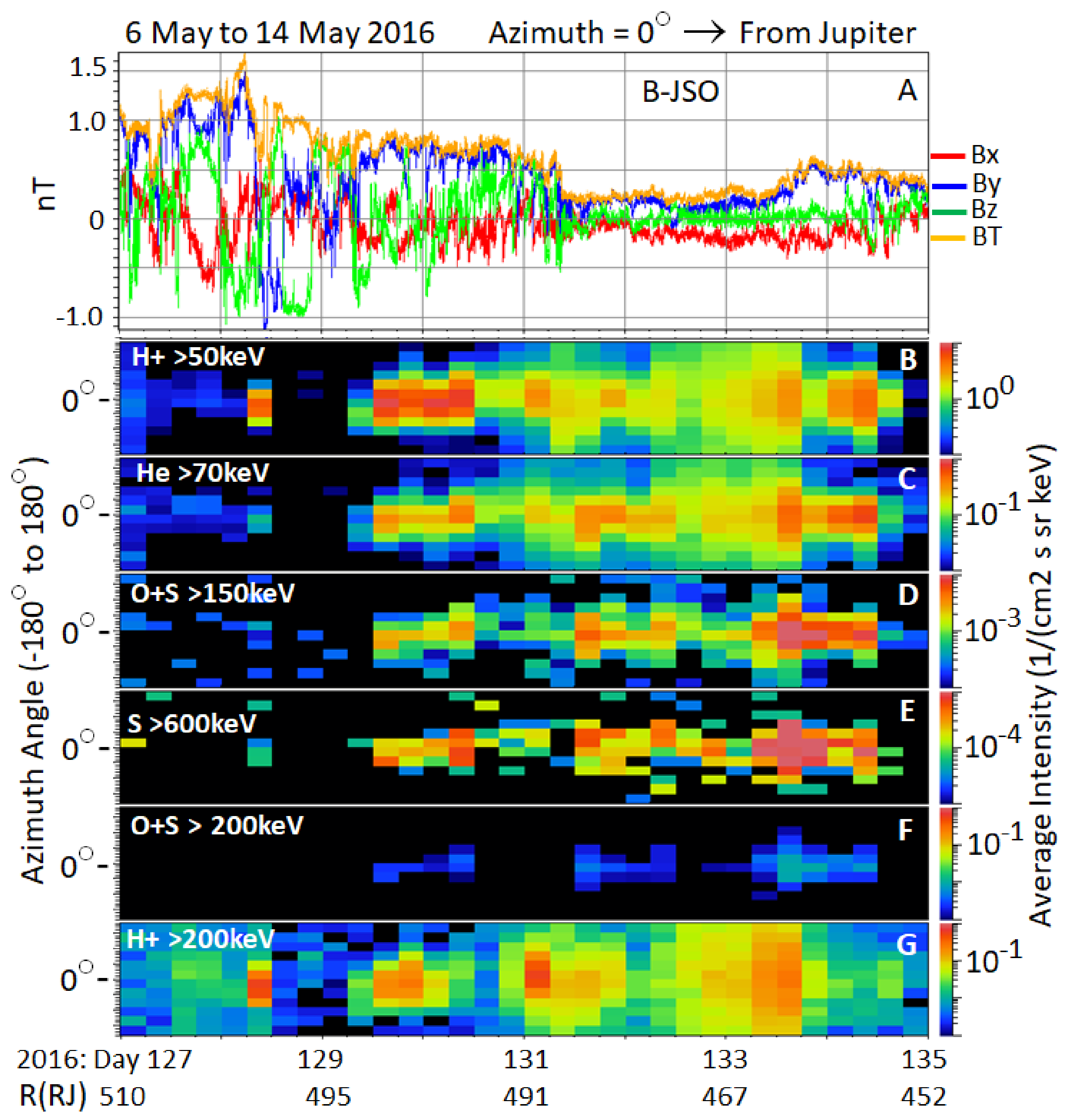
Juno spacecraft approach to Jupiter

Leaking ions are ubiquitous



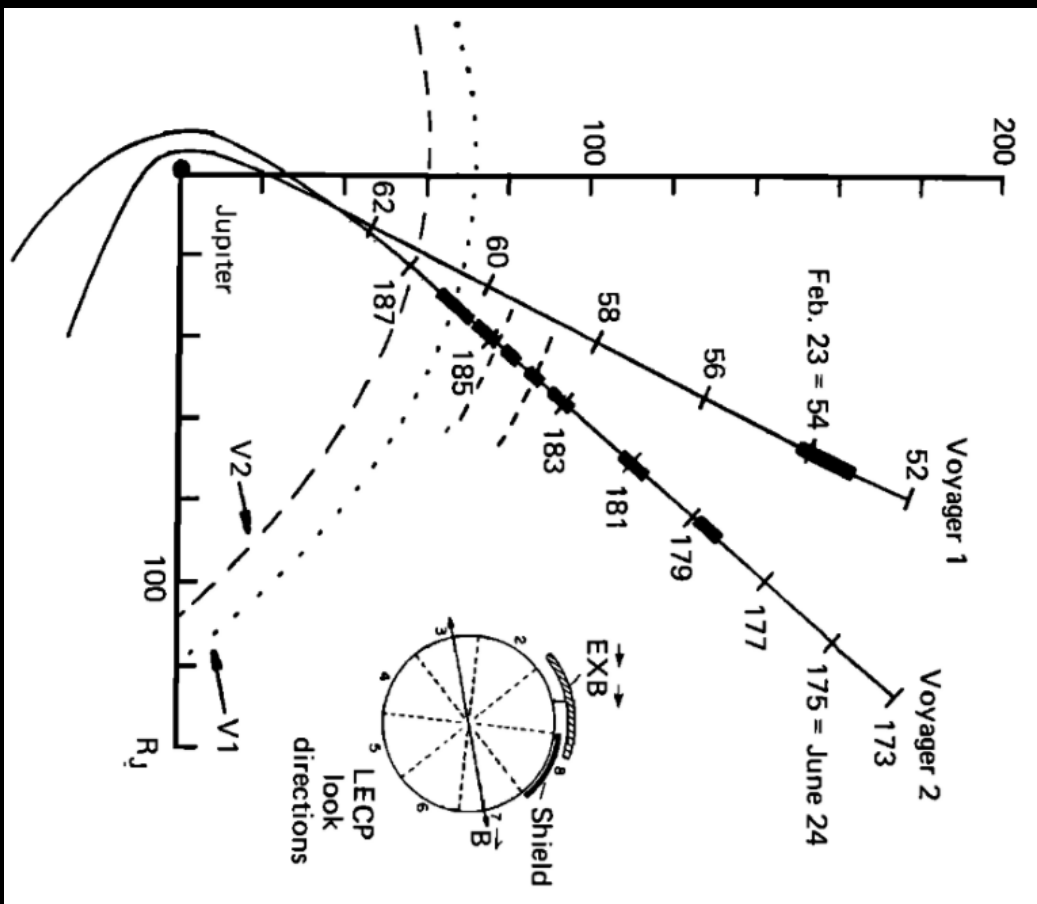
# Juno at 500 RJ

## 0° Azimuth is direction from Jupiter

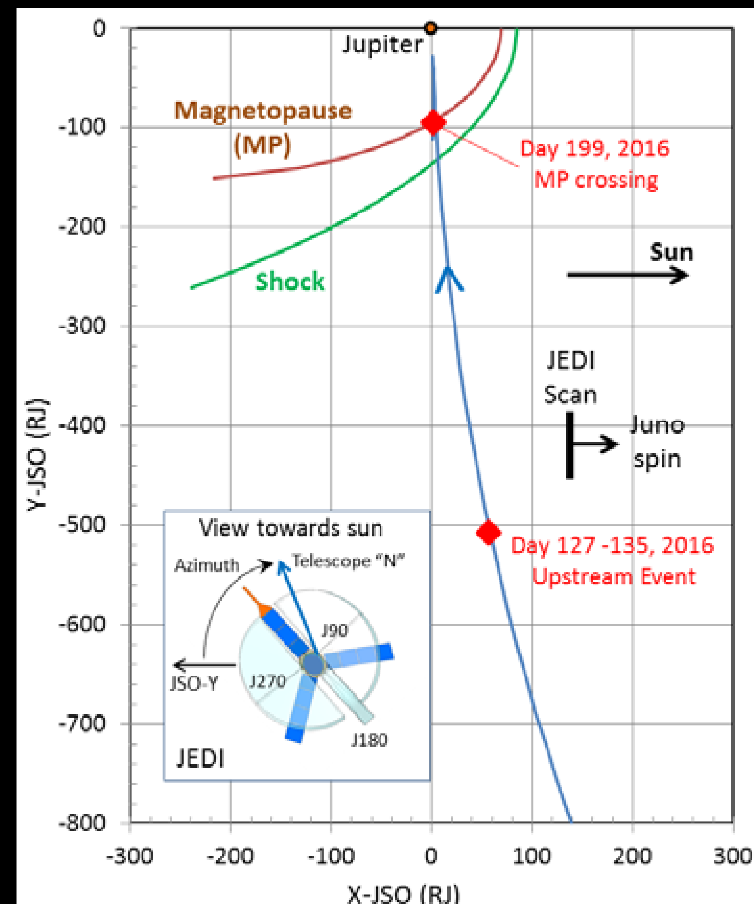


# Voyager and Juno approached Jupiter from different directions. Is that why they saw such different things?

## Voyager Trajectory

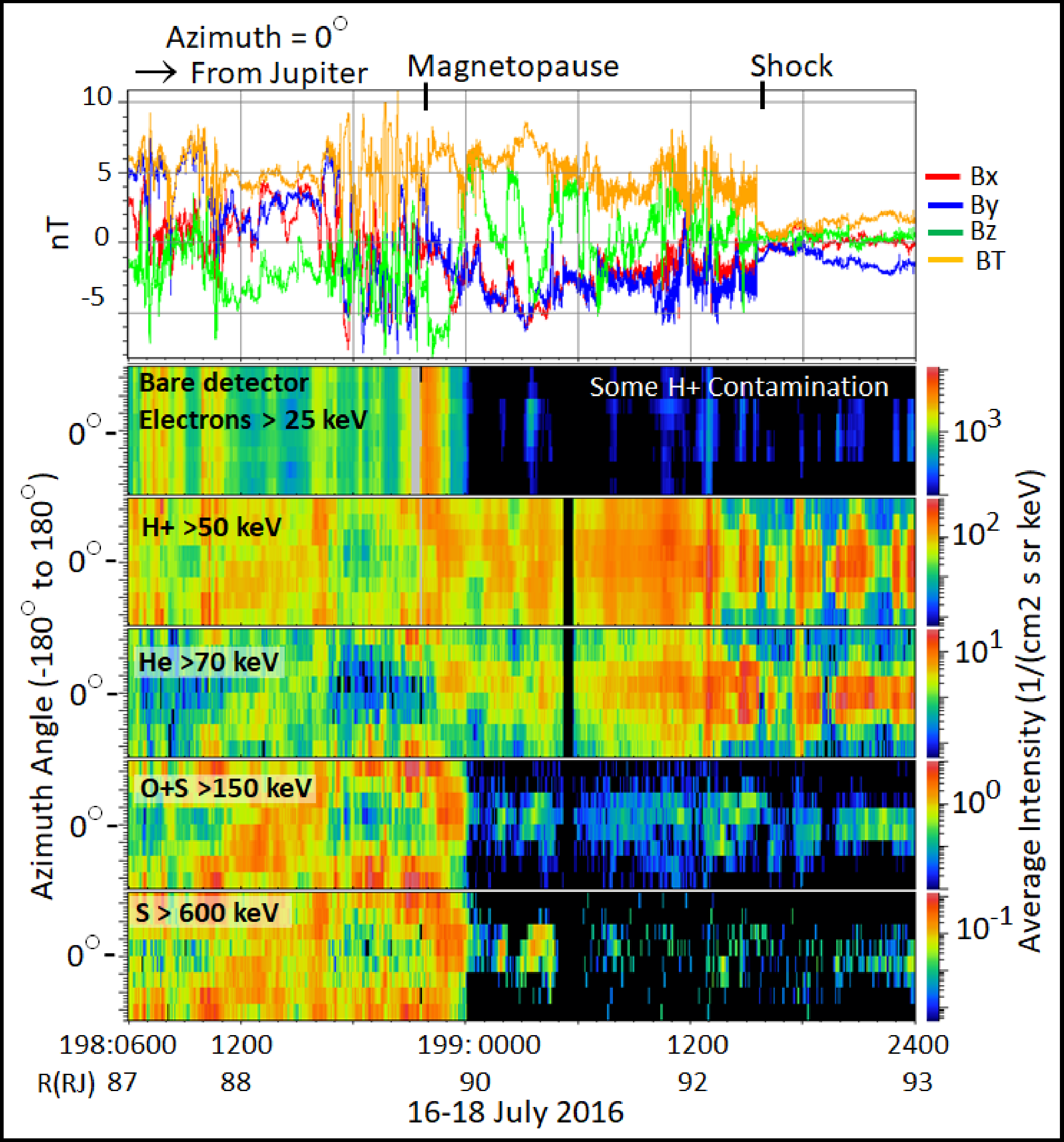



## Juno Trajectory



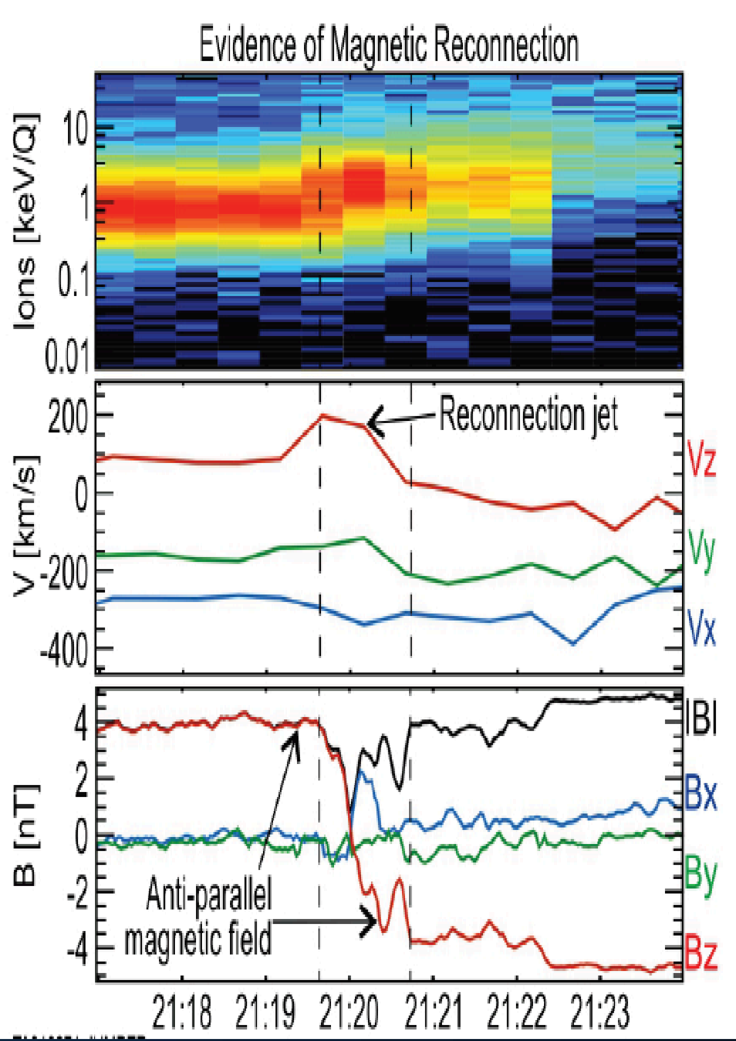
# Juno Crossing Jupiter's magnetopause

The lightest (e-) and the heaviest (O, S) particles have difficulty getting across the magnetopause



# Juno discovers magnetic reconnection at Jupiter's outer magnetospheric boundary

Juno JADE and MAG observations




Ebert et al., 2017, GRL

Reconfiguration of magnetic fields – reconnection – drives dynamic processes at Earth

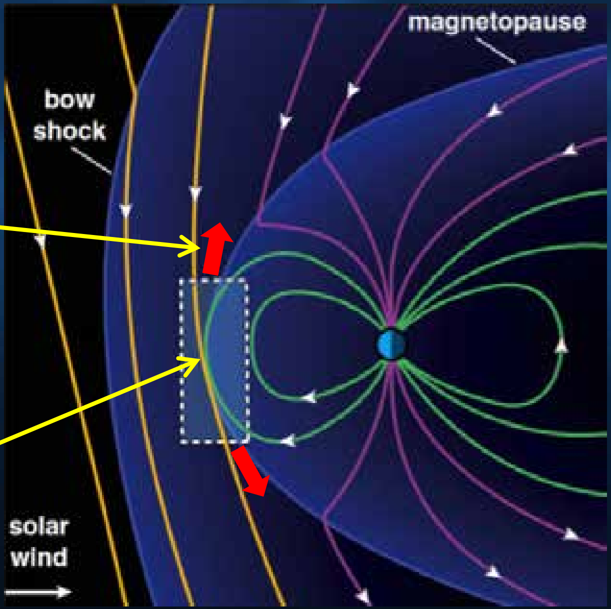
Reconnection expected rare at Jupiter due to solar wind conditions farther from Sun

Juno discovery provides path for solar wind influence on Jupiter's magnetospheric dynamics

Important comparison with Earth observations by NASA's Magnetospheric Multiscale Mission

Reconnection jet

Anti-parallel magnetic fields



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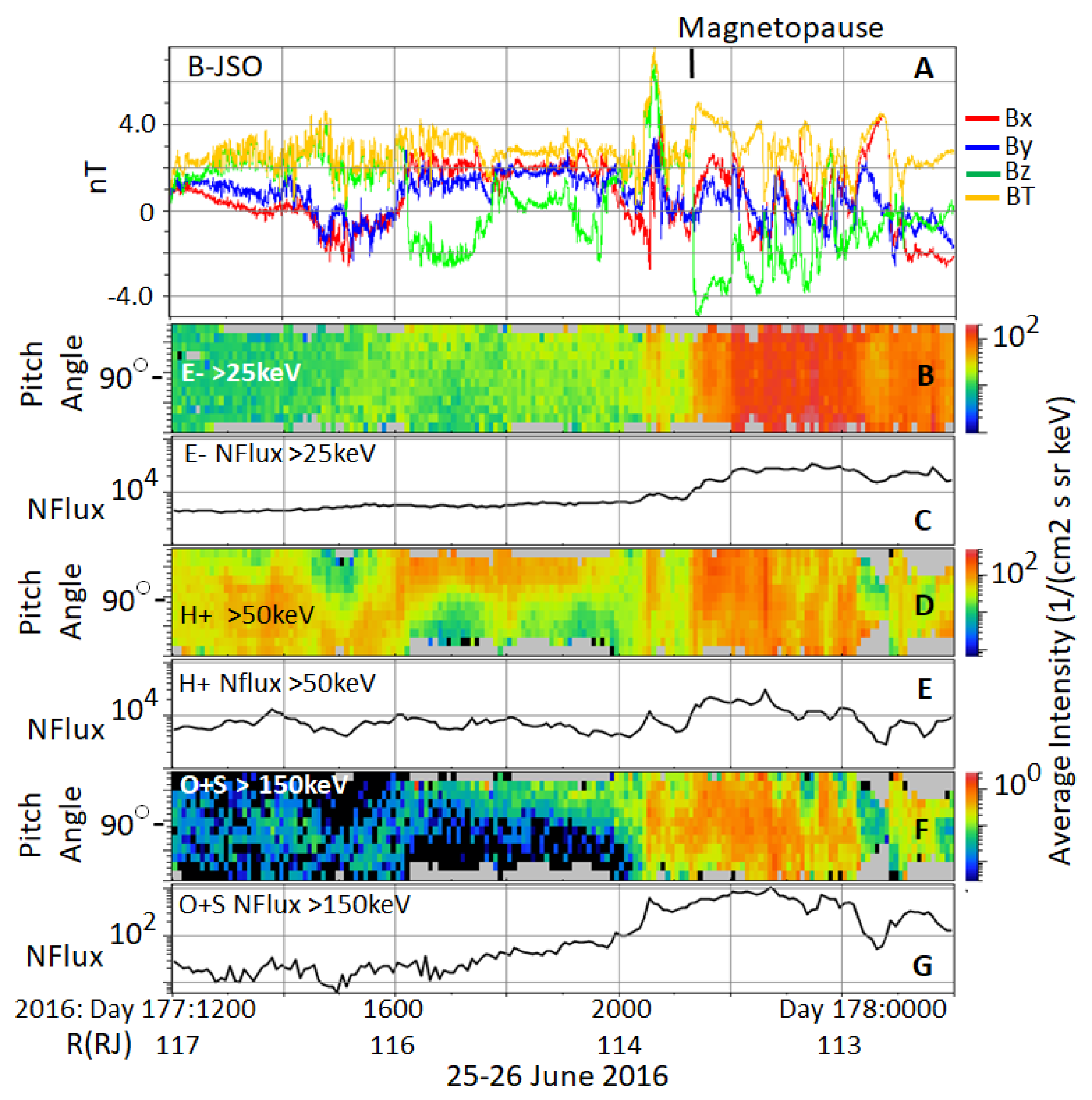
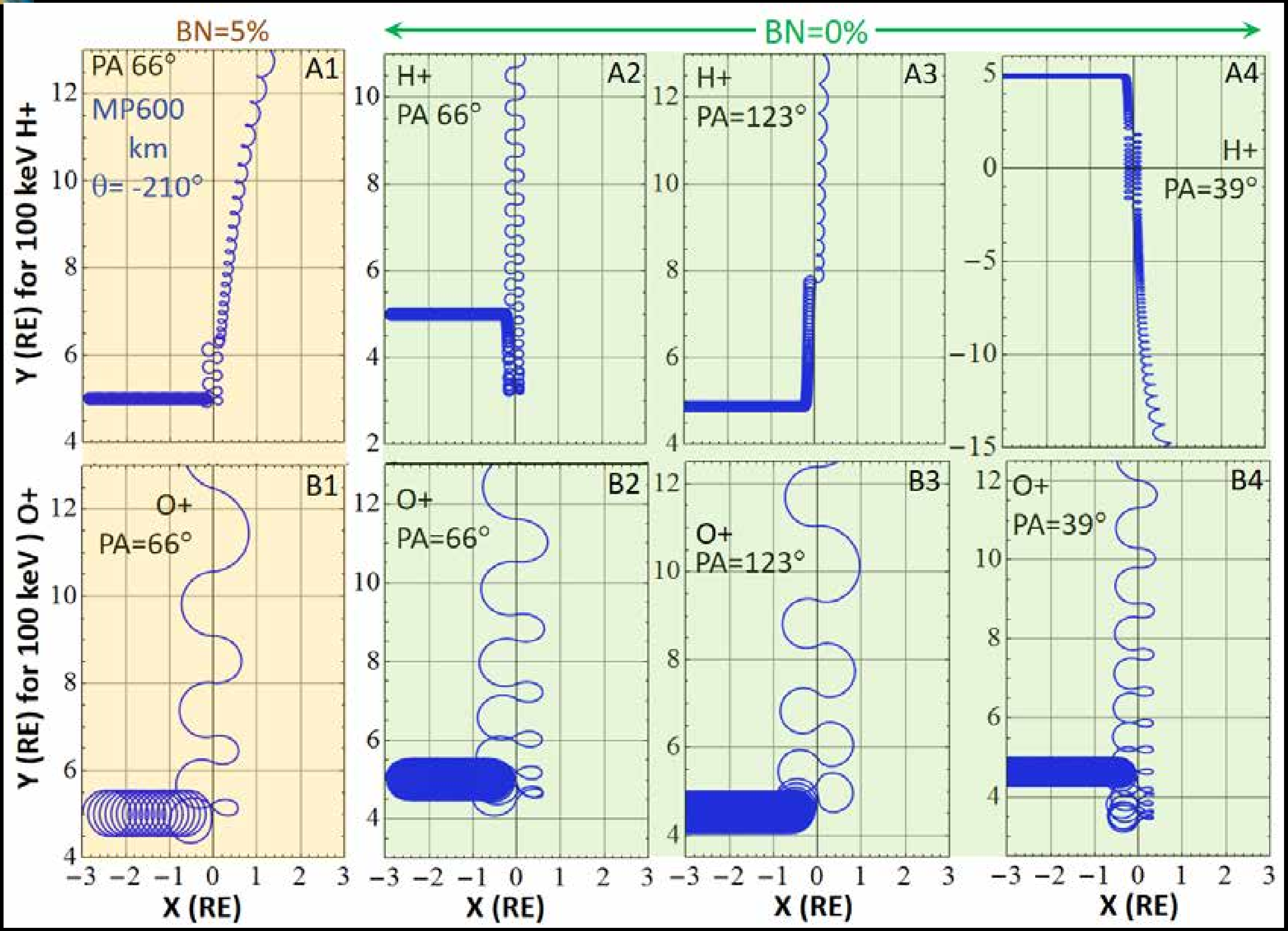


# Conclusions

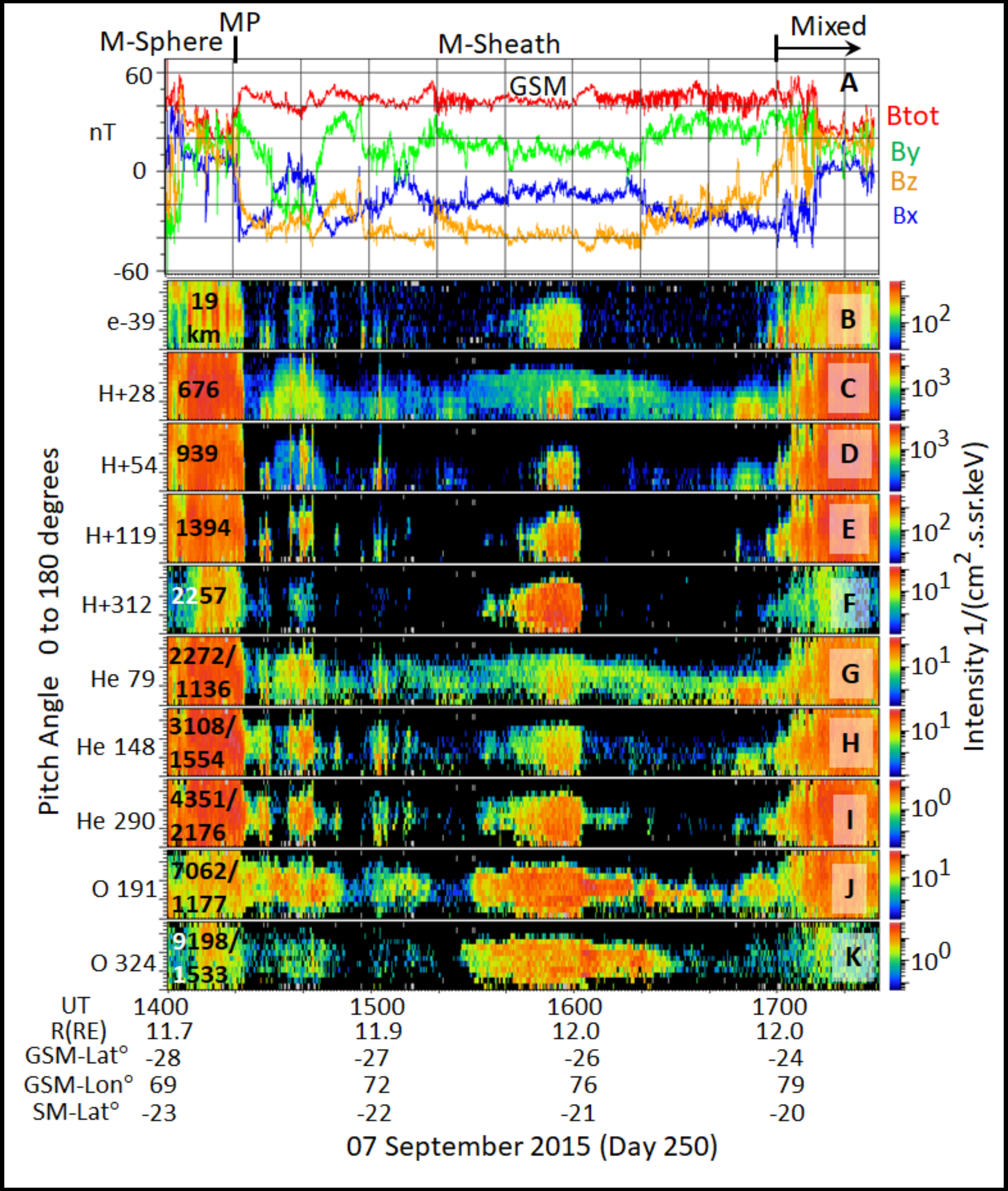
- Key Findings
  - Earth's >100 keV injected magnetospheric $O^+$ ions encountering the magnetopause tend to stay with it and are impeded from fully escaping.
  - Energetic protons, with gyro-radii similar to magnetopause structuring, are more likely to scatter within the boundary and escape.
  - Observations at Jupiter's dawn magnetopause also show that large gyro-radii ions appear less likely to escape than intermediate ones.
- Energetic particles with small gyro-radii (e. g. e-, absent boundary-normal magnetic fields) and those with large gyro-radii (e. g. O+) are both impeded from escaping.
- Energetic particles with intermediate gyro-radii (e. g. H+, $O^{6+}$), commensurate with the sizes of structures within the magnetopause, are more likely to scatter within the boundary and escape.

# BACKUP

# Simple kinetic models show escape is highly mass/charge sensitive



# 07 September 2016



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