Ion Composition of the Magnetosphere of Jupiter

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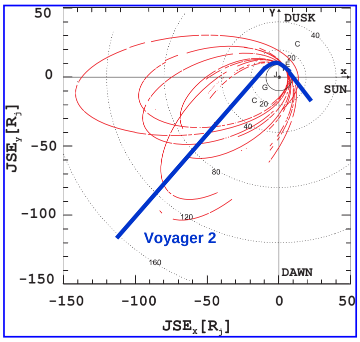
Galileo, as the first orbiting spacecraft of Jupiter, provides the opportunity to study globally the ion composition of the Jovian magnetosphere. This enables to derive the relative importance of the various sources and sinks of plasma and disentangle different acceleration processes. We are analyzing the data coming from the Energetic Particles Detector onboard Galileo and we derive relative ion abundance ratio maps of S/O, S/He, O/He and H/He at various energy/nuc ranges in the Jovian magnetosphere. Composition enhancements associated with magnetospheric dynamic events and acceleration mechanisms are discussed. Comparison with Voyager 2 measurements has shown energy dependent effects and temporal variations of the ion abundance ratios.

Ion sources in the Jovian magnetosphere

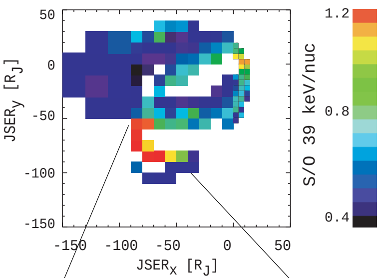
- sulfur ➞ Io
- oxygen ➞ Io (also Europa+ solar wind)
- helium ➞ solar wind
- protons ➞ Jupiter's atmosphere / Europa / solar wind

Trajectories of the Galileo and Voyager 2 spacecraft inside the Jovian magnetosphere



- 15 first Galileo's orbits, close to Jupiter's equatorial plane.
- S, O, H, He EPD measurements: from a few tens of keV to several MeV.

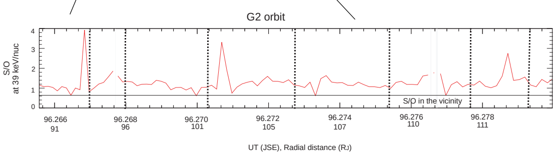
S/O abundance ratio



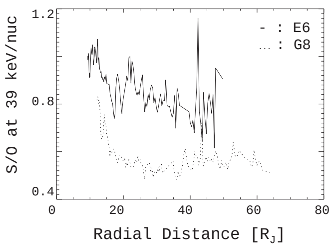
S and O from Io (eV)

transported ↓ accelerated

several 100 keV



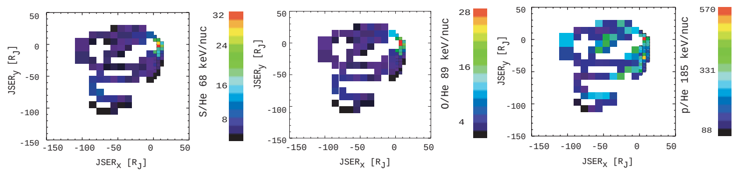
substorm events:
- substorm – dipolarization
- current sheet acceleration



temporal variations:

(temporal variations of the Io torus emissions + magnetospheric dymamics)

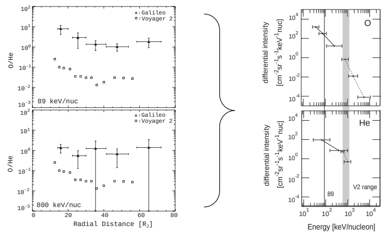
ions/He abundance ratios



- Helium dominates over sulfur and oxygen at larger distance
- p/He increase in the inner magnetosphere => internal sources contribute to the proton population

Comparison with Voyager 2 results

- energy dependence

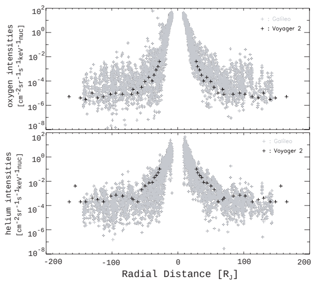


diffusion in energy => Ion stochastic acceleration by Alfvén waves

↓

not sufficient for all distances => radial diffusion is also needed

- time variations



temporal variations between the two missions 17-19 years apart

Conclusions

- Temporal variations of the ion abundance ratios.
- Heavy ion composition enhancements during substorms => current sheet acceleration
- Comparison with the V2 results => energy dependence + temporal variations
- The observed ion energy spectra shapes => ion stochastic acceleration by Alfvén waves + radial diffusion

Publications

Radioti et al., Ion abundance ratios in the Jovian magnetosphere, J. Geophys. Res., 110. doi: 10.1029/2004JA010775, 2005.