Plasma interaction at Io and Europa

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Tidal Heating:

Lessons from Io and the Jovian System

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1. Jupiter’s Magnetosphere
2. Moon-Magnetosphere Plasma Interaction
3. Precipitation, Sputtering, and Space Weathering
4. Signatures of Plumes
5. Magnetic Fields
Giant planet magnetospheres

The magnetospheres of Jupiter and Saturn are...

- Extremely **large**
- Dominated by **rotation** (~10 hrs)
- **Weakly** influenced by the solar wind

At Io and Europa (inside of 10 R_J):

- Magnetospheric magnetic field is
  - VERY STRONG! (Io: ~1800 nT, Europa: ~400 nT)
  - **Mostly** southward.
- Io’s volcanos are the major plasma source for the whole magnetosphere!
  - 1 ton of plasma every second generated from the Io neutral cloud.
Moon-magnetosphere plasma interactions

**Sputtering:**
Magnetospheric ions liberate neutrals, feed a tenuous atmosphere.
[Cassidy et al. 2013, Vorburger & Wurz 2018]

**Ionization:**
Electrons & photons ionize neutrals, populating the ionosphere.

**Pick-up:**
Magnetospheric ions charge-exchange with neutrals, creating fast neutrals and picked-up ions.

\[
E = -u_{\text{plasma}} \times B_J
\]
Precipitation, Sputtering, Space Weathering

**Thermal Plasma (<100 eV)**

- Magnetospheric O\(^+\) Downward Flux
- Ionospheric O\(_2^+\) Downward Flux

**Suprathermal plasma**

- Paranicas et al., GRL, 2001

(Please see also my poster!)

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Paranicas et al., Icarus, 2014
Signatures of Plumes

Jia et al., Nature Ast., 2018

Blöcker et al., JGR-SP, 2016
Magnetic Fields

Khurana et al., Science, 2011

Jovian background, No induction
Warm solid mantle
Various asthenospheres

(Please see also my poster!)