Towards a Carbon Nanotube Ionization Source for Planetary Atmosphere Exploration
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**Technology Objective**

A carbon nanotube electron gun (CNTEG) is constructed for the highly sensitive exploration of exospheres, i.e. extremely tenuous atmospheres \( (n < 10^8 \text{ cm}^{-3}) \). The CNTEG is based on the quantum principle of field emission seeking to efficiently impact and therefore ionize diffuse neutrals known to be present around planetary bodies.

**Exosphere Ionization**

**Europa EGM**

The Exospheric Global Model (EGM) is a 3D parallelized Monte Carlo code developed for the characterization of exospheres. Here, we model Europa. Test particles are ejected from Europa’s surface up to \( \sim 15 \text{ R}_E \), following known energy distributions. The test particles are on ballistic trajectories and can escape, stick, and bounce on the surface. Furthermore the particles can be dissociated/ionized by physisochemo processes.

**Results**

Extended Exosphere Clouds are simulated, due to:

- Jovian gravitational drag is evident.
- Similar to sodium clouds at Io².
- Escape rates could indicate an Enceladus-like hydrotorus.

Perspectives from Surface-Exosphere inhomogeneities:

- Sputtering may not be global².
- \( O^+ \) may not be dominant.
- Water-product escape rates match previous studies ².
- \( O_2 \) is thermalized to \( T_{\text{ex}} \), speeds are not sufficient to populate upper exosphere.

**References**