Towards a Carbon Nanotube Ionization Source for Planetary Atmosphere Exploration

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A Carbon Nanotube Electron Gun (CNTEG) is developed to ionize neutral atmospheres for future space spectrometry missions. 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 10 R₉, 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 physicochemical processes.

**Fig. 8:** EGM domain modeling physical processes in spherical coordinates.

**Results**

- Jovian gravitational drag is evident.
- Similar to sodium clouds at Io⁹.
- Escape rates could indicate an Enceladus-like hydrotorus.

**Perspectives from Surface-Exosphere inhomogeneties:**

- Sputtering may not be global.⁹
- 0⁺, S⁺ ions may not dominate.⁶
- Water-product escape rates match previous studies.⁷
- O₂ is thermalized to Tₑ, speeds are not sufficient to populate upper exosphere.

**References:**


**Fig. 4:** CNTEG emission vs gate voltage. Gate voltage 1-6 V.

**Fig. 5:** Upper exospheric oxygen behavior is identical to other water-products: H₂, OH, H₂O. Day-night symmetry is apparent. Effect is less for neutral hemisphere as anti-jove is close to anti-jove.