

Effect of Magnetic Connectivity on CubeSat Needle Probe Measurement

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We investigate numerically the impact of magnetic field orientation on needle Langmuir probe (NLP) onboard nano-satellites. For this purpose, we model the interaction between the CubeSat and ionospheric plasma under realistic plasma conditions by using the 3D Particle-In-Cell code PTetra. The magnetic field and plasma parameters are estimated from the International Geomagnetic Reference Field (IGRF) and International Reference Ionosphere (IRI) models, respectively.

The study demonstrates the effect of magnetic field connectivity by computing the current-voltage characteristics of the NLP on a 3U CubeSat. Three different orientations of the magnetic field are considered such that the probe spacecraft system is either magnetically connected or magnetically disconnected. The magnetically connected case corresponds to the orientation of the magnetic field in which the magnetic field lines intersect the NLP and the satellite body. Conversely, in the magnetically disconnected case the magnetic field lines intersect the probe but do not intersect the

spacecraft body. The current characteristics of the needle probe computed for the cases considered, illustrate the sensitivity of the collected current to the orientation of the magnetic field. It can be inferred that the effect of the magnetic field connectivity can also be taken in to account for the interpretation of in situ measurements of the needle Langmuir probes on CubeSats. The present study will be helpful to understand the detailed interaction between nano-satellites and the low Earth orbit plasma environment.

References

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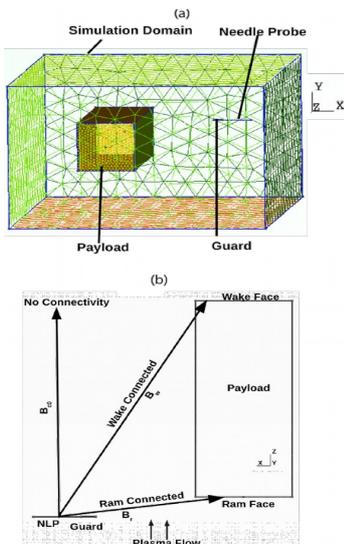


Figure 1: Illustration of the idealized geometry of the 3U CubeSat (panel a) and of the magnetic connectivity (panel b).

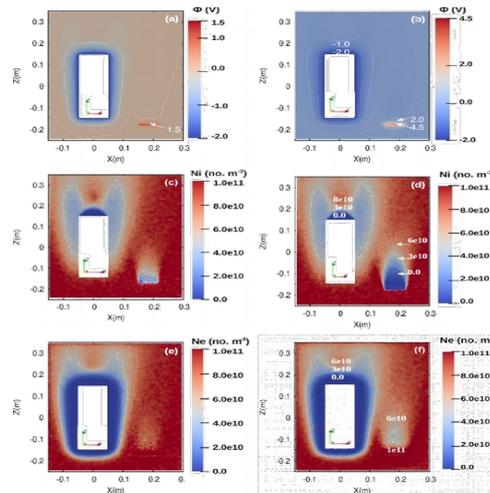


Figure 2: Cross sections of electric potentials (a and b), ion densities (c and d) and electron density (e and f) profiles for the magnetically disconnected case for probe biasing +1.5 V (left column) and +4.5 V (right column) relative to the satellite body.

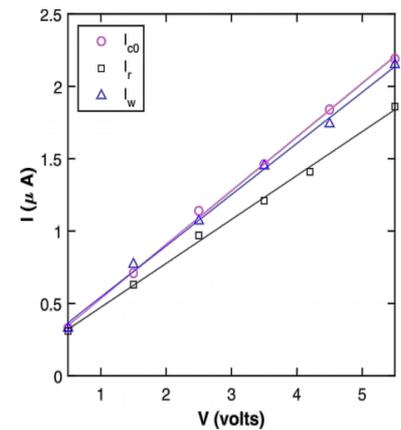


Figure 3: Currents collected as a function of bias voltage, for the three magnetic connectivity considered. Subscripts r, w, and c0 refer respectively to ram and wake magnetically connected, and magnetically disconnected cases.