Modeling Spacecraft Charging around Irregularly Shaped Small Asteroids

Chen Cui and Joseph Wang

Department of Astronautical Engineering, University of Southern California, Los Angeles, CA 90089

Small airless bodies represent the next frontier in solar system exploration. However, proximity exploration of small asteroids present several extremely challenging issues for spacecraft. One of the challenges is the spacecraft charging risk. While spacecraft charging has been studied extensively for earth-orbiting spacecraft, few studies have addressed spacecraft-plasma interactions near small asteroids. Results from earth-orbiting spacecraft cannot be easily extrapolated to predict spacecraft charging near small asteroids because asteroids can produce a highly complex local plasma charging environment. This paper presents a numerical investigation of plasma interaction and charging for spacecraft near irregularly shaped small asteroids. Large-scale particle-in-cell simulations are carried out with a mesh resolution that resolves both the local plasma sheath around spacecraft and a simulation domain that contains the global plasma flow field around asteroid. Spacecraft charging is calculated directly from charge deposition on spacecraft. Spacecraft charging results will be presented for several different asteroid shapes and ambient plasma environments. The location relative to asteroid for worst local spacecraft charging will be identified, and the likelihood for electrostatic discharge will be discussed.