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NUMERICAL SIMULATION OF SATELLITE CHARGING FOR ELECTROMAGNETIC ORBITAL CONTROL

Abstract

It is known that a satellite is charged by plasma in space. Satellite charging on surface is a cause of discharge and malfunction electric equipment, therefore a satellite is normally designed to mitigate surface charging. But recently, a new concept of the satellite orbital control using the electromagnetic forces such as lorentz force and coulomb forces has been proposed. This control method provides propellantless orbital control and very lightweight propulsion system compared to conventional chemical and electric propulsion. For this reason, various applications are expected. In order to achieve the electromagnetic orbital control, to establish a method to control satellite potential arbitrarily is required. In general, satellite potential is determined by the balance of inflow current and outflow current. Hence potential can be controlled with forced current emission on surface. In this study, we investigate the satellite charging characteristics with electron emitter or proton emitter by using Particle-in-cell code. We simulate charged particle beam emission on surface of perfect conductive 1 meter cubic satellite in geosynchronous earth orbit. As a result, in the case of electron beam emission, satellite potential become +800 V, and amounts of charge become $+6.1 \times 10^{-8}$ C with 3 mA electron beam emission. In the case of proton beam emission, satellite potential become -3.3 kV, and amounts of charge become -2.8×10^{-7} C with 3 mA proton beam emission. Maximum emission current is limited by electrical power and space charge limited current. Thus it is found that achievable charge-to-mass ratio of the satellite, which determines the magnitude of the control force of charged satellite, is on the order of 10^{-7} C/kg. In addition, we estimate feasible formation flight orbit of charged satellite on obtained charge-to-mass ratio.