Paper ID: 8169
student

SPACE PROPULSION SYMPOSIUM (C4)
Special Session on "Missions Enabled by New Propulsion Technologies and Systems" (6)

Author: Dr. Leonard Felicetti
Sapienza University of Rome, Italy, leonard.felicetti@uniroma1.it

Prof. Fabio Santoni
University of Rome "La Sapienza", Italy, fabio.santoni@uniroma1.it

NANOSATELLITE MISSIONS FOR IN SITU LOW ORBITAL HEIGHT ATMOSPHERIC MEASUREMENTS ENABLED BY LASER PROPULSION RE-ORBITING

Abstract

In situ atmospheric measurements at low orbital heights are necessary to build accurate atmospheric models and in particular to contribute to the development of a global, real time, space weather forecasting service, following the high variability of the atmospheric environment and allowing accurate predictions of LEO object trajectories and maneuver planning. Missions for real-time in situ atmospheric measurements have been recently proposed, based on nanosatellite swarms. The main limitation in these missions is the effect of atmospheric drag, which dissipates the orbital energy making the nanosatellite re-enter and burn quickly in the Earth atmosphere. Therefore, the operative orbit height must be sufficiently high to guarantee a meaningful orbital lifetime, justifying the launch and sophisticated instrumentation costs. Using a propulsion system, the useful satellite lifetime could be extended and at the same time the operative orbit height could be lowered, to explore more interesting zones. However, conventional propulsion systems, namely chemical and electric propulsion systems, are not compatible with the on board resources constraints imposed by nanosatellites, in terms of mass and power. Innovative propulsion techniques enabling atmospheric measurement missions at low altitudes should be investigated. Among these, laser propulsion offers great weight and power potential savings, obtained separating the propulsion system energy source from the satellite. The energy source for the propulsion system is a laser beam generated remotely, while only a collecting mirrors and ablative material are necessary on the target spacecraft. The mission proposed in this paper is based on the idea that the source of the propulsion energy necessary for the whole nanosatellite swarm can be concentrated in one or more large satellites orbiting at higher altitudes, where the atmospheric drag can be easily compensated. Energy is transferred to the low orbit target nanosatellites by a laser beam, that impinges on the nanosatellite's surfaces, vaporizes a cover slide of ablating material, giving net thrust to the target nanosatellite. Nanosatellites that eventually re-enter the Earth atmosphere can be replaced by newly launched ones, while the higher orbit satellites carrying the laser source equipment can be maintained, with potential reduction of the overall system costs. The mission is designed taking into account long term orbital perturbations on the target nanosatellite swarm and on the laser source spacecraft. The laser sustained re-orbiting maneuver sequence is optimized, depending on the relative orbital geometry, showing that the laser propulsion system is an enabling technology for low altitude nanosatellite aeronomy missions.