ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1) (1)

Author: Dr. Ming Xu
Beihang University, China, xuming@buaa.edu.cn

Mr. zuopeng wang
China, wangzuopenglove@126.com
Ms. Li Huang
China, lilyhappy0717@126.com

COMBINED AERODYNAMIC AND ORBITAL TRAJECTORIES FOR PARTIAL DRAG-FREE FLIGHT IN SUPER LOW ALTITUDE

Abstract

Classical remote sensing satellites are always flying on sun-synchronous orbits with their altitude between 500 and 700km to achieve the images of 1m resolution. Nowadays the slight advances in imaging instruments, such as the focus of camera and the image element of CCD, have prevented the satellite from improving image quality; however, an innovative and economical manner to improve the resolution is to enforce the satellite flying on the lower altitude. In recent years, the advances in electric propulsion have significant contribution in postponing the satellite's life on the super low altitude below 200km. Different from the Gravity Field and Steady-State Ocean Circulation Explorer (GOCE, ESA) employing electric propulsion to balance all the aerodynamic forces experienced by the satellite, to compensate only the drag force is referred as the partial drag-free flight in near space. Thus, the aerodynamic lift is remaining to create combined aerodynamic and orbital trajectories, especially in the super low altitudes. The partial drag-free flight has potential application in some military tasks since the aerodynamic lift makes the trajectories are unpredictable by non-allied spacecrafts.

There exist several inflection points on the partial drag-free trajectories, the topology of which has the similar with the boost-glide missile or reentry spaceship. The mechanism is concluded from the viewpoint of combined aerodynamic and orbital mechanics, that the inflection point is occurring when the aerodynamic lift is larger than the gravity, and the lift not only brings forward the perigee but also augments the altitude of perigee. And then some numerical simulations are implemented to validate the existence of inflection points.

A systematic investigation is presented on the topologic geometries of combined aerodynamic and orbital trajectories for boost-glide missile, reentry spaceship and partial drag-free flight. From the numerical simulations, it is concluded that the number of inflection points are dependent on the lift coefficient (Cl), drag coefficient (Cd), windward area (S) and mass (m). Thus, two variables Cd*S/m and Cl*S/m are identified as the essential parameters to demonstrate the two-dimensional distribution for the number of inflection points, which may act as the useful tool to select the suitable aerodynamic parameters or configuration for a specified mission.