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# INFLUENCE OF SPACE DEBRIS ATTITUDE MOTION ON ION BEAM ASSISTED REMOVAL MISSION COSTS

**Abstract**

Systems of active space debris removal based on contactless interaction are a promising direction of the astronautics development. The absence of the mechanical contact with the retractable space object makes the whole system safer, since unsuccessful docking or tethered capture of space debris can cause an accident and the creation of new debris. Contactless ion beam based systems can be very effective for cleaning debris, and they can be created using existing technologies. The magnitude and direction of the force arising from the blowing of space debris by the ion flux depends on the debris shape and its orientation in relation to the flow. In the general case, the force application point does not coincide with the center of mass of the space debris, which leads to the appearance of a torque tending to change the orientation of the space debris. A change in orientation in turn causes a change in force. The effect of the space debris attitude motion on the dynamics of the entire system during space debris deorbiting is not sufficiently studied in the scientific literature.

The aim of this work is to study the effect of space debris attitude motion on removal mission costs. To achieve this goal, a mathematical model of a system consisting of an active spacecraft and space debris, which is a solid body, is developed using the Lagrange formalism. The active spacecraft is considered as a material point, and it is equipped with marching engines and an engine that creates an ion beam. The dynamics of the unperturbed motion of space debris in a circular orbit with a constant relative position of the active spacecraft is studied. The phase portraits of the unperturbed system are constructed and the average values of the ion beam force on various phase trajectories are calculated. The most favorable angular motion mode for the space debris removal mission is found. Modeling and cost comparison for two methods of space debris deorbiting are carried out. In the first case the active spacecraft control system does not take into account the angular motion of the space debris. In the second case, the direction of the ion beam axis was controlled for transport in the favorable angular mode. The results of numerical simulations showed that attitude motion of the space debris has a noticeable effect on time and fuel costs.