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DYNAMICS OF A SATELLITE WITH FLEXIBLE PANELS DURING ION BEAM ASSISTED REMOVAL MISSION

Abstract

The space debris mitigation is one of the most important challenges of modern astronautics. Researchers pay great attention to active large space debris removal systems, which imply the use of active spacecraft to transport space debris objects to the atmosphere or to disposal orbits. Ion beam-based contactless space debris removal systems are a promising direction in solving this problem. This approach implies exerting a force effect on a space debris object by blowing it with a high-velocity ion flow generated by an active spacecraft's thruster. The absence of direct mechanical contact between the active spacecraft and the space debris object provides greater safety for contactless space debris removal systems. Another advantage of ion beam-based space debris removal systems is the possibility of their creation based on existing technologies. The targets for active space debris removal missions are upper rocket stages and non-functional satellites. Many satellites are equipped with solar panels, the presence of which creates additional difficulties during transportation. Elastic oscillations of these flexible panels can have a significant effect on the space debris object motion relative to its center of mass, and in particular, lead to chaos. In addition, because these panels have a large area, they are able to contribute greatly to the force and moment generated by the ion beam. The aim of this work is to study the dynamics of a non-functioning satellite with attached flexible elements under the action of an ion beam created by an active spacecraft. To achieve this goal, a mathematical model that describes the motion of a satellite under the action of an ion beam is developed in a planar statement using the Lagrange formalism. The dynamics of the unperturbed motion of the satellite in a circular orbit with solidified panels treated as a solid is studied. The results of numerical simulations show that small oscillations of flexible panels cause chaos. An assessment of the influence of possible chaotic satellite motions on the safety of the ion beam transportation operation is given. The results of the work can be used to prepare space debris removals missions aimed at non-functional satellites with solar panels.