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CHAOTIC BEHAVIOR OF A PASSIVE SATELLITE DURING TOWING BY A TETHER

Abstract

Transport operations in space using tether systems is a most promising technology currently developed in the world. A towing of nonfunctional satellites and orbital stages to the boundary of the atmosphere using tethered space tug relate to such operations. The paper deals with the motion of a tether system, which includes three elements: a passive satellite, a space tug and a viscoelastic tether. Its focus is on the study of attitude motion of the system under the action of a thrust tug and a gravitational moment. The aim of the work is to determine the main features of motion of the tether system depending on its characteristics. The obtained attitude motion equations show that under certain conditions there may be an unstable equilibrium position, which could lead to chaos. In this case, the tether system may unpredictably change your position relative to the line of action of the thrust tug, which coincides with the local horizontal in this task. We have found a condition which excludes the existence of unstable equilibrium position as a source of the chaos. This condition depends on the tether length, mass and thrust of the tug. In this paper we detailed study the case when there is instability. The attitude motion is divided into two classes (disturbed and undisturbed) for small deflection angles of the tether from the local horizontal. Homoclinic orbits are determined in an analytical form and Melnikov function is found for prediction of the chaos. The analytical results given by the Melnikov method have been confirmed by a good agreement with direct numerical calculations in the construction of Poincaré sections. The Poincare sections confirm the existence of chaos, as in the case for the small deflection angles of the tether as well as for the general case of the motion. The paper provides guidelines for choosing the parameters of the system (the thrust tug, the mass tug, the tether length and viscoelastic properties of the tether) depending on the mass of the towed body which do not occur chaos. The results of the paper can be useful in the design of the space towing system.