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Author: Prof. Alexander Rodnikov
N.E. Bauman Moscow State Technical University, Russia, Russian Federation, avrodnikov@yandex.ru

ON DYNAMICS OF A SPACE STATION TETHERED TO AN OBLATE ASTEROID

Abstract

To realize some space missions one can place a space station near a small planet. To except running away, one can tether the station to the asteroid surface. Estimating technical difficulties, one can present this problem as composition of three components. The first component includes geometrical and dynamical characteristics of the asteroid. In this paper we assume the small planet is a rigid body that is oblate and is close to dynamically symmetric. This is a reason to replace gravitational potential of the asteroid with potential of two conjugate complex masses being on the imaginary distance. (This idea had been realized for the first time by V.G. Demin in 1959 for the Earth gravitational potential). Evidently, the made assumptions imply rotation of the asteroid is close to a regular precession. Note that in this case the station motion equations are equations of the Generalized Restricted Circular Problem of Three Bodies (GRCP3B). (GRCP3B had been suggested by V.V. Beletsky in 2005). The second component is the method of tethering. In this paper we assume the station coasts along a tether with ends placed at the asteroid poles, more precisely, at tops of the towers constructed on the poles. (Here poles are common points of the asteroid surface and of the axis of dynamical symmetry.) Such tether is called 'the leier'. The third component is the mission goals. In this paper we find the station equilibria on the leier. (Note that in general case the station moves w.r.t. the asteroid surface even if it is immovable w.r.t. the leier.) We establish that these equilibria form some curves in two planes. The first plane passes axes of precession and of dynamical symmetry, the second plane crosses the asteroid mass center orthogonally to the precession axis. In particular, the found curves can be infinite, endless or have ends in the libration points (LP) of GRCP3B. (Here LP is relative equilibrium of a free (non-tethered) particle w.r.t. axes of precession and of dynamical symmetry.) Also we deduce stability conditions for the found equilibria if motion along the leier is forbidden. In addition, we analyze the station motion along the leier if the nutation angle is zero or right. Depicted phase portraits include areas of motion with the weakened tether