

Horseshoe periodic orbits for Saturn coorbital satellites

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Abstract

We consider the motion of coorbital satellites in the framework of the Restricted Three-Body problem for $\mu = 6.5 \cdot 10^{-9}$. We show a mechanism to generate horseshoe periodic orbits and we compute some families of horseshoe periodic orbits when varying the Jacobian constant. We conclude that there exist stable horseshoe periodic orbits which fit with the motion of Saturn coorbital satellites Janus and Epimetheus.

Key words and expressions: coorbital motion - horseshoe periodic orbits - Restricted problem.

1. Introduction

In 1981 the successful Voyager flights to Saturn confirmed the existence of two small satellites of Saturn, Janus (1908S1) and Epimetheus (1980S3), and provided an estimate of their masses as well as their orbital elements. These coorbital satellites turned out to be librating in horseshoe orbits, in a convenient rotating system, since their semimajor axis are only 50 km apart, they can approach within 15.000 km, but when they are close to each other, their mutual gravitational interaction prevents a collision and switches their orbits.

Several authors have dealt with the coorbital motion in the framework of the planar three-body problem: from an astronomical point of view (see Taylor 1981, Dermott and co-workers 1981, and Yoder et al. 1983), and also mathematical theories have been developed (see Spirig and Waldvogel 1985 and 1988 and Hénon and Petit 1986).