Solar Sailing in the Earth-Moon System: Dynamical Equivalents

Ariadna Farrés, Àngel Jorba and Marc Jorba-Cuscó
Departament de Matemàtiques i Informàtica
Facultat de Matemàtiques
Universitat de Barcelona. *

June 3, 2016

Abstract

Solar sailing is a new proposed form of spacecraft thruster. It is composed of large and highly reflecting membranes intended to exploit the effect of Solar Radiation Pressure (SRP). The acceleration due to SRP, while smaller than the one achieved by traditional propellers, is continuous and only limited by the lifetime of the sail. During the last years, a number of Solar Sail missions have been projected in the vicinity of the Earth-Moon system. However there is still a small number of publications in the literature concerning the dynamics of a solar sail in the Earth-Moon system. Moreover, all of them take only into account the gravitational influences of Earth and Moon while it is known that the influence of Sun's gravity plays an important role in the real system.

Here, we consider the motion of a solar sail in the Earth-Moon system taking into account the gravitational influence of Earth, Moon and Sun and restricting ourselves to the ecliptic plane. The acceleration provided by the SRP depends on two parameters: the effectivity of the sail and its orientation. We consider a two degrees of freedom non-autonomous periodic time dependent Hamiltonian system. This model can be regarded as a periodic perturbation of the Earth-Moon Restricted Three Body Problem. Our study consists on a comprehensive numerical study of the dynamical equivalents of the Lagrangian points. That is, we perform massive continuations with respect the parameters of the system.

Finally, we compare the results of our model and the model without Sun's gravity. We also comment about the applicability of both models and give some hints to construct an improved model.

*marc@maia.ub.es, http://www.maia.ub.edu/