Generalised analytical results on n-ejection-collision orbits in the RTBP

Tere M-Seara[1,2,3], Mercè Ollé[1,2,3], Ó. Rodríguez* [4], and Jaume Soler[5]

[1] *Dept. Matemàtiques, Universitat Politècnica de Catalunya, Av Diagonal 647, 08028 Barcelona, Spain*
[2] *IMTech, Universitat Politècnica de Catalunya, Pau Gargallo 14, 08028 Barcelona, Spain*
[3] *CRM, Campus de Bellaterra Edifici C, 08193 Bellaterra, Spain*
[4] *Dipartimento di Matematica, Università di Pisa, Italy*
[5] *Dept. Enginyeria Civil i Ambiental, Universitat Politècnica de Catalunya, Campus Nord, edifici C2, 08034 Barcelona, Spain*

May 2, 2022

Abstract

We prove the existence of four families of n-ejection-collision (n-EC) orbits in the planar circular restricted three-body problem and for any value of the mass parameter $\mu \in (0,1)$ and $n \geq 1$. The n-EC orbits are the ones where the particle ejects from a primary, reaches n maxima in the distance with respect to it and finally collides with the primary. Such EC orbits have a value of the Jacobi constant of the form $C = 3\mu + Ln^{2/3}(1-\mu)^{2/3}$, where $L > 0$ is big enough but independent of μ and n. In order to prove this optimal result, we consider Levi-Civita's transformation to regularize the collision with one primary and a perturbative approach using an ad hoc small parameter once a suitable scale in the configuration plane and time has previously been applied. Moreover, for decreasing values of C, there appear some bifurcations which are first numerically investigated and afterwards explicit expressions for the approximation of the bifurcation values of C are discussed. Finally, a detailed analysis of the existence of n-EC orbits when $\mu \to 1$ is also described. In a natural way Hill's problem shows up. For this problem, we prove an analytical result on the existence of four families of n-EC orbits and numerically we describe them as well as the appearing bifurcations.

*oscar.rodriguez@upc.edu