Dynamics of charged particles in planetary magnetospheres

M. Iñarrea[(1)], V. Lanchares[(2)], J. F. Palacián[(3)], A. I. Pascual[(2)], J. P. Salas[(1)] and P. Yanguas[(3)]

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[(1)] Área de Física Aplicada, Universidad de la Rioja, 26006 – Logroño, La Rioja, Spain.
[(2)] Departamento de Matemáticas y Computación, Universidad de la Rioja, 26004 – Logroño, La Rioja, Spain.
[(3)] Departamento de Ingeniería Matemática e Informática. Universidad Pública de Navarra. Campus de Arrosadía, 31006 – Pamplona, Spain).

Abstract

The dynamics of a charged particle orbiting around a rotating magnetic planet is studied. We take into account the influence of the planetary oblateness (J_2) in the dynamics. The system is modelled by the Hamiltonian of the two–body problem perturbed by an axially–symmetric function which goes to infinity as soon as the particle approaches the planet. The perturbation consists in a magnetic dipole field and a corotational electric field. When it is weak compared to the Keplerian part of the Hamiltonian we average the system with respect to the mean anomaly up to first order in terms of a small parameter defined by the ratio between the magnetic and the Keplerian interactions. After truncating higher–order terms we use invariant theory to reduce the averaged system by virtue of its continuous and discrete symmetries, determining also the successive reduced phase spaces. Then we study the flow of the resulting system in the most reduced phase space, describing all equilibria and their stability, as well as the different classes of bifurcations. Finally, we connect the analysis of the flow on these reduced phase spaces with the one corresponding to the original system. We prove the existence of invariant 3–tori of the original system from the relative equilibria of the reduced one.

References

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