Integrability versus chaos in non-autonomous Hamiltonian systems. Applications to the study of some transport phenomena

Dana Constantinescu[1], Marie-Christine Firpo[2]

[1] *Department of Applied Mathematics, Association Euratom-MECT, University of Craiova, 13 A.I. Cuza Str, Craiova 200585, Romania* dconsta@yahoo.com

[2] *Laboratoire de Physique des Plasmas, C.N.R.S. - Ecole Polytechnique* ,91128 Palaiseau cedex, France
marie-christine.firpo@lpp.polytechnique.fr

The phase space of some Hamiltonian systems is a complex mixture of invariant zones whose points have regular, respectively chaotic dynamics. The regular zones (where the system is almost integrable) are characterized by a reduced transport. Such zones act sometimes as transport barriers which separate different chaotic zones. Inside the chaotic zone the transport is increased, due to the mixing properties of the system.

In this paper we propose general results concerning the existence and the localization of internal transport barriers for Hamiltonian systems with periodical perturbation in 1 ½ degrees of freedom. We systematically study the influence of the parameters which define the unperturbed Hamiltonian on the transport properties.

The results are applied for the study of the magnetic transport in tokamaks (toroidal devices used for obtaining energy through controlled thermonuclear fusion). In this case the formation of internal transport barriers is crucial for the (desired) plasma confinement because it prevents the radial transport of charged particles.