Master 2 Internship

Centre de Physique Théorique, UMR 7332 and IRFM CEA

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Title : **Chaotic motion of charged particles in magnetic fields, applications to fusion plasmas.**

General Context:
In the last few years, the impact of low dimensional chaos in the motion of charged particles in ideal plasma configurations has been shown to be able to destroy quasi-invariants in some regions of the phase space. Most notably the existence of an adiabatic constant, namely the magnetic moment μ, which is at the heart of the gyrokinetics reduction appeared to be questionable in these regions, or when it exists, this was shown not to imply the integrability of the dynamics, even in axisymmetric magnetic fields [1, 2]. This local invariant breaking could be a major concern, most notably when considering transport predictions coming out of gyrokinetic codes, which are often considered as "first principles" results by the community. During this internship the student will familiarize himself with the problems, and develop new tools both conceptual and numerical. One of the problems being able to analyze for a large time (up to adiabatic times) particle trajectories that belong to a 6th dimensional phase space and that potentially develop Hamiltonian Chaos. At first we would need to assess the efficiency of an algorithm to compute trajectories using high order Taylor expansions versus a 6-th order symplectic one. After that preliminary set up, we expect to study the dynamics and evolution of particle density functions of « stable » and perturbed configurations.

Scientific Environment: This internship work will be part of a long standing collaboration of the CPT with the IRFM of the CEA Cadarache within the French national research federation of magnetic confinement fusion (FR-FCM).

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[1] B. Cambon, X. Leoncini, M. Vittot, R. Dumont, and X. X. Garbet. Chaotic motion of charged particles in toroidal magnetic configurations. *Chaos*, 24:033101, 2014.

[2] S. Ogawa, B. Cambon, X. Leoncini, M. Vittot, D. Del Castillo-Negrete, G. Dif-Pradalier, and X. Garbet. Full particle orbit effects in regular and stochastic magnetic fields. *Phys. Plasmas*, 23:072506, 2016.