Master-2 internship proposal

Lab: Centre de Physique Theorique (CPT), UMR 7332, Aix-Marseille Universite - Luminy

Research team: E7: " Systèmes dynamiques: théorie et applications"

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Level (M1, M2 or both): M2

Group Size: This is part 2 of a group of 3 separated subjects (somewhat related), for 1 student.

Project title:

Hamiltonian Description of the Electrodynamics, via the Poisson Algebra of Maxwell-Vlasov. Application to the Physics of Magnetically Confined Plasmas, in Tokamaks (like ITER).

Abstract:

This project will study the Hamiltonian approach of classical electrodynamics, via (non-canonical) Poisson structures. This relativistic Hamiltonian framework (introduced by Morrison, Marsden, Weinstein) is independent of the gauge potentials, and is well suited for a perturbation theory, in a strong inhomogeneous magnetic field (expansion in 1/|B|, with all the curvature terms...). This algebraic and geometric description of the Maxwell-Vlasov kinetics yields some very concrete applications. For instance the reduced dynamics of the "gyrocenter", or "guiding-center" dynamics, in order to improve the efficiency of the computation and the confinement of the magnetically confined plasmas.

This is important in view of the thermonuclear fusion, as in Tokamaks (international project ITER, in CEA-Cadarache) or Stellarators. The geometric approach may be implemented in any coordinates, for instance adapted to the Tokamak (toroidal coordinates or even more adapted...).

This Master2 project consists in a short introduction to this framework. And it can eventually be continued into a PhD thesis.

References: P. J. Morrison: "Poisson brackets for fluids and plasmas"
AIP Conference Proceedings 88, 13 (1982)
