	Master in Physics FunPhys 2022-2023

Master (M2) Stage 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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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 Master project consists in an introduction to this framework, and expliciting the first steps of the procedure.

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

P.J. Morrison, M. Vittot, L. de Guillebon: "Lifting particle coordinate changes of magnetic moment type to Vlasov-Maxwell Hamiltonian dynamics", Physics of Plasmas, 20, 3 (2013). Archived on ArXiv/1212.3007.