Subject 1: Ergodisation of the magnetic field

Title: **Hamiltonian Chaos and Lagrangian structures in divergence free fields**

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A numerical method is proposed in order to track field lines of three-dimensional divergence free fields. Field lines are computed by a locally valid Hamiltonian mapping, which is computed using a symplectic scheme. The method is theoretically valid everywhere but at points where the field is null or infinite. For any three dimensional flux conservative field for which problematic points are sufficiently sparse, a systematic procedure is proposed and implemented. Construction of field lines is achieved by means of tracers and the introduction of various Hamiltonians adapted to the "geometrical state" each line or tracer is. The states are artificially defined by an a priori given frame of reference and Cartesian coordinates, and refer to a Hamiltonian which is locally valid at the time step to be computed. This procedure ensures the preservation of the volume (flux condition) during the iteration. This method is first tested with an ABC-type flow. Its benefits when compared to typical Runge-Kutta scheme are demonstrated. Potential use of the method to exhibit "coherent" Lagrangian structures in a chaotic setting is shown. An illustration to the computation of magnetic field lines resulting from a three-dimensional MHD simulation is also provided.