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Description of magnetic field lines in fusion plasmas by the Hamiltonian formalism

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In tokamaks, the superposition of a toroidal magnetic field, due to external coils around the entire torus, and the poloidal field, generated by the plasma current itself, is responsible for the plasma confinement. An interesting situation is when the magnetic field is time-independent, as is the case in MHD equilibrium configurations. For a symmetric plasma equilibrium configuration with an ignorable coordinate, i.e., the toroidal angle in tokamaks, the magnetic field line equations can be cast in the form of canonical equations, if the ignorable coordinate plays the role usually assigned to physical time in classical mechanics[1]. As the magnetic field is divergence free, we can describe the field lines using an area-preserving map, with respect to a section of the torus at a fixed toroidal angle[2]. The resulting phase space of the field lines is identical to a Hamiltonian phase space, indicating that the field lines act, at least locally, as trajectories. The analogy between the Hamiltonian formalism and the equations for the magnetic field lines is extremely useful since we can use the methods of Hamiltonian theory to interpret the results and characterize the dynamic regimes observed in experiments and computational simulations. Magnetic field lines are a non-mechanical example of a system that can be described by the Hamiltonian formalism[3]. From the variational principle, we were able to present the description of field lines in confined plasmas for different coordinates and with the inclusion of an external perturbation.

[1] Bernardin, M. P., & Tataronis, J. A. (1985). Hamiltonian approach to the existence of magnetic surfaces. *Journal of Mathematical Physics*, 26(9), 2370-2380.
[2] Morrison, P. J. (2000). Magnetic field lines, Hamiltonian dynamics, and nontwist systems. *Physics of Plasmas*, 7(6), 2279-2289.
[3] Viana, R. L., Mugnaine, M., & Caldas, I. L. (2023). Hamiltonian description for magnetic field lines in fusion plasmas: A tutorial. *Physics of Plasmas*, 30(9).

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