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Analytical solutions for the guiding centers magnetically confined in a sphere

Guiding Centre theory has been developed to describe the dynamics of charged particles subject to the Lorentz force. In the context of fusion theory, it is used in numerical simulations to find approximate trajectories of particles in an external field which can be locally approximated by a straight uniform one, but also the collective effect of an ensemble of such particles as a part of a magnetized plasma.
We propose a non-perturbative formulation of Guiding Centre theory, by which it is possible to find exact trajectories of the charged particles under the influence of magnetic fields typically found in fusion devices,and in particular in spherical ones.
In this work we start by reviewing the non-perturbative formulation of Guiding Centre theory and we deduce the solutions for toroidally symmetric magnetic fields with spherical boundary conditions. Then, with the appropriate corrections to the existing codes, the particles distribution and their confinement can be computed.

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