Reference Magnetic Coordinates (RMC) for adaptive grid simulations of toroidal plasma

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The issue of an appropriate coordinate system for ergodic magnetic fields is as old as the world of 3-D toroidal configurations and remains unresolved. The destruction of nested magnetic surfaces even by small 3-D perturbations leads to a sudden change of topology of magnetic field. As a result, the coordinate systems cannot be longer based on tracing the magnetic field lines.

At the same the high plasma anisotropy requires use of field aligned coordinates. Recently, the additional demand came from disruption simulations which need adaptive grids for resolving processes localized at the plasma edge.

The talk describes the RMC (introduced in 1997, 1 year B.L.), which resolve the issue and represent the best simply nested coordinates for ergodic confinement fields. The remarkable fact is that RMC can be constructed numerically using a simple and fast algorithm not involving field line tracing.

New coordinates can have variety of application in plasma confinement theory and perturbed particle motion. E.g., RMC suggest a new approach for calculation of 3-D stellarator equilibria, where magnetic islands and stochasticity cause numerical problems.

For non-linear MHD studies, RMC, aligned dynamically with magnetic field, give a practical approach for adaptive grid generation and would dramatically relax the grid size and time step requirements in MHD codes. Implementation of RMC will constitute a transition from the current wasteful hydrodynamic numerical schemes for plasma MHD to the plasma physics based algorithms consistent with the plasma anisotropy.