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Weakly Ideal MHD

Robert L. Dewar[1], Zhisong Qu[1]
[1] Mathematical Sciences Institute, The Australian National University
robert.dewar@anu.edu.au

The gap between a recently developed dynamical version of relaxed magnetohydrodynamics (RxMHD) and ideal MHD (IMHD) has been bridged [1] by approximating the zero-resistivity ``Ideal" Ohm's Law (IOL) constraint using an augmented Lagrangian method borrowed from optimization theory. The augmentation combines a pointwise vector Lagrange multiplier method and global penalty function method and can be used either for iterative enforcement of the IOL to arbitrary accuracy, or for constructing a continuous sequence of magnetofluid dynamics models running between RxMHD (no IOL) and weak IMHD (IOL almost everywhere). This was illustrated by deriving dispersion relations for linear waves on an MHD equilibrium.

A potential application is as the basis for a numerical method for constructing stellarator equilibria with weakly chaotic magnetic fields, in which the ergodic partition into magnetic islands and “stochastic” regions is fractal, yet which support pressure gradients.

References

R.L. Dewar & Z.S. Qu, “Relaxed Magnetohydrodynamics with Ideal Ohm's Law Constraint” *J. Plasma Phys.* **88**, 835880101 (2022) https://dx.doi.org/10.1017/S0022377821001355