Links
Email Organisers
Program

Admin only

A novel variational principle for three-dimensional plasma equilibria*

Robert DEWAR, Stuart Hudson, Matthew Hole and Mathew McGann

The Australian National University
& Princeton Plasma Physics Laboratory

Email: robert.dewar@anu.edu.au

Typical astrophysical and fusion plasmas are highly nonequilibrium systems, but on intermediate time scales they self-organize to a quasi-steady "equilibrium" state where magnetic and pressure forces balance. To model such quasi-equilibrium states Woltjer [1] and Taylor [2] proposed a variational principle based on minimization of total plasma energy under the single global constraint of constant magnetic helicity (replacing the infinite number of frozen-in flux constraints in ideal-MHD and allowing magnetic reconnection). The Euler–Lagrange (Beltrami) equation $\nabla \times \mathbf{B} = \lambda \mathbf{B}$, where λ is a constant, is physically correct in regions where the magnetic field is chaotic. The Hamiltonian field line chaos problem makes the existence of MHD equilibria in non-axisymmetric magnetically confined toroidal plasmas problematic [3], but a new variational principle [4] based on Woltjer–Taylor relaxed regions separated by invariant "KAM" tori promises to at last provide a practical and mathematically well-posed formulation of this long-standing problem.

[1] "On Hydromagnetic Equilibrium", L. Woltjer, Proc. Nat. Acad. Sci. (USA) **44**, 833 (1958)
[2] "Relaxation of Toroidal Plasma and Generation of Reverse Magnetic Fields", J. B. Taylor, Phys. Rev. Letters **33**, 1139 (1974)
[3] "Toroidal containment of a plasma", H. Grad, Phys. Fluids **10**, 137 (1967)
[4] "Eigenvalue problems for Beltrami fields arising in a three-dimensional toroidal magnetohydrodynamic equilibrium problem", S. R. Hudson, M. J. Hole and R. L. Dewar, Phys. Plasmas **14**, 052505 (2007)
*Research supported by Australian Research Council Discovery project DP0452728.

Student Talk: N
Plenary Talk: N
Poster: N

Review Abstract   Submit Abstract