

MAGNETOHYDRODYNAMIC RELAXATION

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ABSTRACT

The equations of Magnetohydrodynamics (MHD) describe the evolution of an electrically conducting fluid. The resistive term in the MHD equations is for most astrophysical and also many technical plasmas very small. If one neglects this term (ideal MHD), the equations have an infinite number of conserved quantities related to the conservation of the topology of the magnetic field. On the other hand, even with very small resistivity strong current sheets can develop in localised regions leading to magnetic reconnection. This raises the question which ideal invariants are still approximate invariants in the limit of small, but non-vanishing, resistivity. We will discuss a number of numerical relaxation experiments which we have performed on plasmas with complex, braided, magnetic fields to find out which invariants govern the relaxation process towards a minimum energy state. This includes a critical review of Taylor's theory [1], as well as a discussion of the role of turbulence [2, 3].

This is joint work with Anthony Yeates and Alexander Russell.

- [1] Taylor, J.B. 1986 Relaxation and Magnetic Reconnection in Plasmas. *Rev. Mod. Phys.* **58**, 741.
- [2] Yeates A.R., Russell A.J.B. and Hornig, G. 2015 Physical role of topological constraints in localized magnetic relaxation. *Proc. R. Soc. A.* **471**, 20150012.
- [3] Yeates, A.R., Russell, A.J.B. and Hornig, G. 2021 Evolution of field line helicity in magnetic relaxation. *Phys. Plasmas* **28**, 082904.