Computation of multi-region relaxed magnetohydrodynamic equilibria

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We describe the construction of stepped-pressure equilibria as extrema of a multi-region, elaxed magnetohydrodynamic (MHD) energy functional that combines elements of ideal MHD and Taylor relaxation, and which we call MRxMHD. The model is compatible with Hamiltonian chaos theory and allows the three-dimensional MHD equilibrium problem to be formulated in a well-posed manner suitable for computation, and numerical solutions are constructed using the stepped-pressure equilibrium code, SPEC.

Highlights of recent calculations will be presented and discussed, including: that the self-organized single-helical-axis (SHAx) and double-axis (DAx) states in reversed field pinch experiments can be reproduced; that MRxMHD can recover ideal MHD; and the SPEC code is used to compute (for the first time) the singular current densities predicted in ideal MHD equilibria in three-dimensional geometry and a new class of solution to the ideal MHD equilibrium equation will be presented. Some ongoing developments of MRxMHD and SPEC will be discussed, including: vacuum verification calculations of W7-X equilibria; free-boundary, non-up-down symmetric DIIID calculations, and including a non-trivial flow into the energy principle.