

# SPEC computes extrema of the multi-region, relaxed MHD energy principle

- The plasma is partitioned into N “relaxed volumes”, separated by “ideal interfaces”.
- Minimize the total energy, subject to the constraints of conserved fluxes and helicity in each region

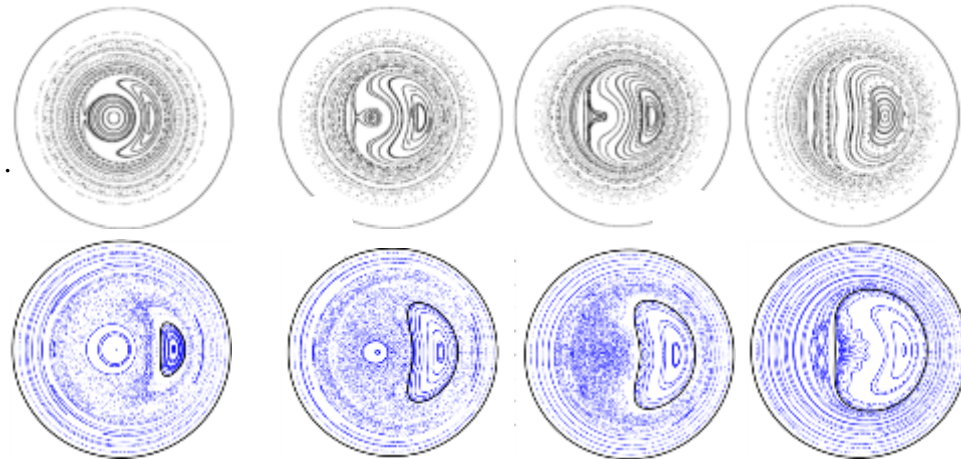
$$F \equiv \sum_{i=1}^N \left[ \underbrace{\int_{\mathcal{V}_i} \left( \frac{p}{\gamma-1} + \frac{B^2}{2} \right)}_{\text{energy}} - \frac{\mu_i}{2} \left( \underbrace{\int_{\mathcal{V}_i} \mathbf{A} \cdot \mathbf{B} - K_i}_{\text{helicity}} \right) \right]$$

- In the relaxed volumes,  $\nabla \times \mathbf{B} = \mu \mathbf{B}$ , and islands, chaotic fields are allowed.
- Across the ideal interfaces,  $[[p+B^2/2]]=0$ , and pressure gradients are allowed.
- If  $N = 1$ , obtain a globally-relaxed, Taylor state.
- If  $N \rightarrow \infty$ , recover ideal MHD  $\nabla p = \mathbf{j} \times \mathbf{B}$ .
- If  $N = 2$ , explains helical states in RFP

## Overview of RFX-mod results,

P. Martin et al., *NF*, (2009)

Fig.6. . . . transition from a QSH state . . . to a fully developed SHAx state .



## Numerical Calculation using Stepped Pressure Equilibrium Code,

G. Dennis et al., *PRL*, (2013)

Topological features correctly reproduced