# REACTORS WITH STELLARATOR STABILITY AND TOKAMAK TRANSPORT

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Since the W7-AS and LHD stellarator experiments exceeded theoretical $\beta$ limits, the ARIES_CS study has been considering more realistic simulations that use the NSTAB code. The problem may be that force balance and stability are lost across islands if the equilibrium equations are not in conservation form.

There are compact stellarators with either two or three field periods that are good candidates for a reactor. Progress has been made in reducing the prompt loss of $\alpha$ paricles.

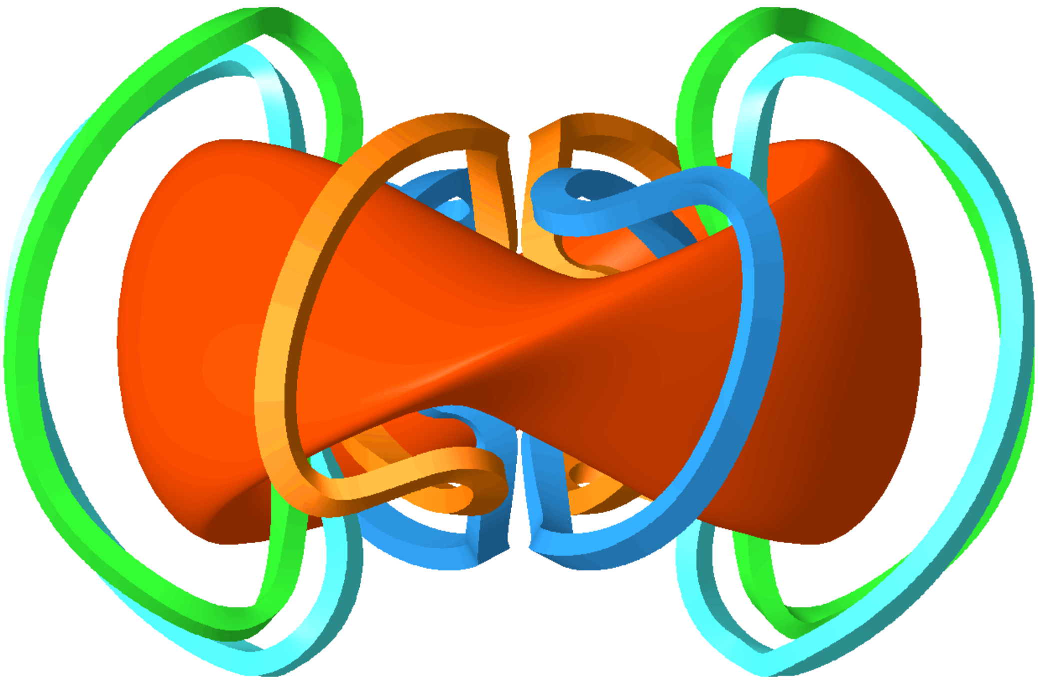


Diagram of a two field period stellarator with $A = 2.5$ designed by running the NSTAB equilibrium code. Eight moderately twisted modular coils needed to produce the external field are shown. Maintenance seems to be feasible through ports between each pair of coils. (Courtesy of Tak-Kuen Mau and Tsueren Wang.)

$$\int\int\int[\frac{1}{2}B^2 - p(s)]\,dV \;=\; \mathrm{minimum}$$

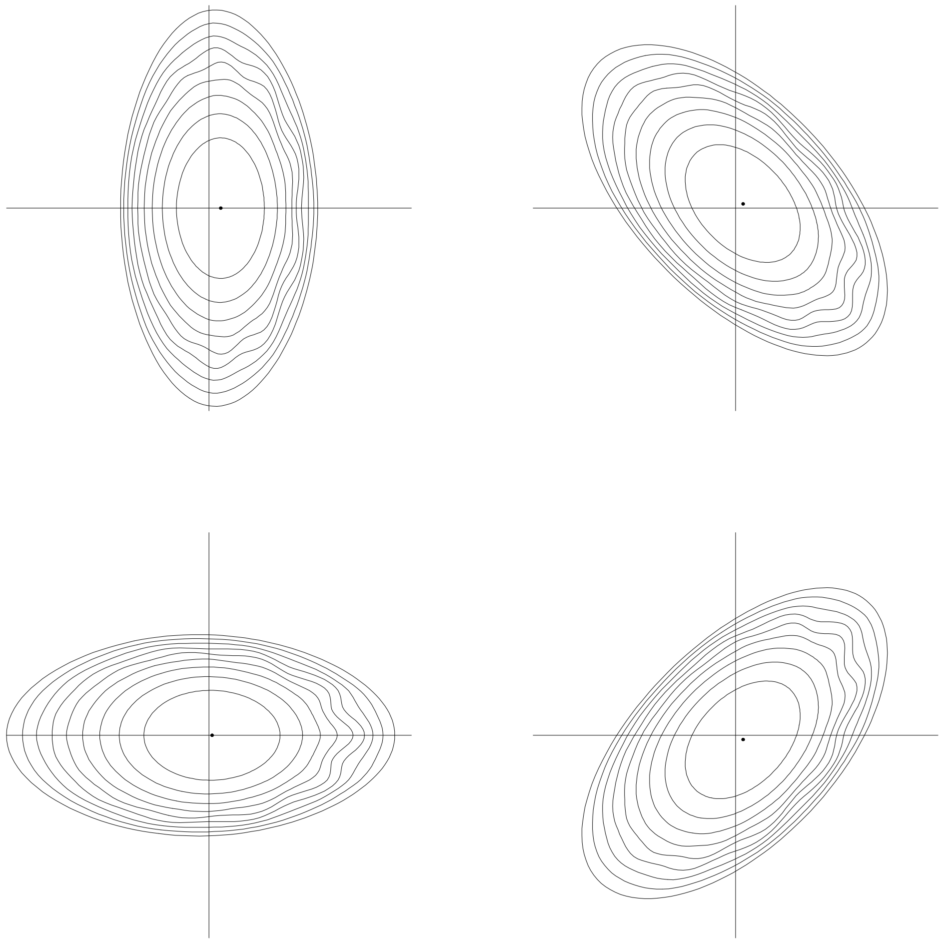
$$\nabla\cdot\mathbf{B} \;=\; 0\,, \;\; \nabla\cdot[\mathbf{B}\,\mathbf{B} \;-\; (B^2/2 + p)\,\mathbf{I}] \;=\; 0$$

$$\mathbf{B} = \nabla s \times \nabla\theta = \nabla\phi - \zeta\nabla s\,, \;\; \mathbf{J} = \nabla s \times \nabla\zeta$$

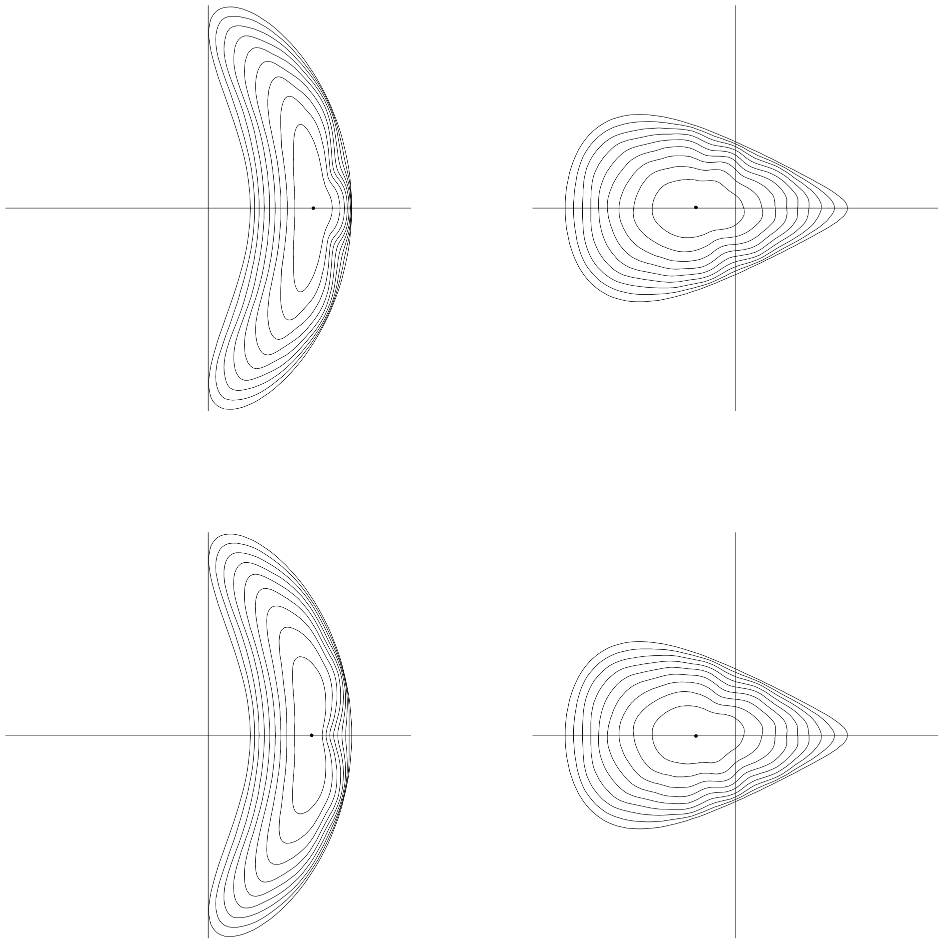
$$\frac{1}{B^2} = \Sigma\, B_{mn}\cos(m\theta - [n - \iota m]\phi)$$

$$\zeta = p'\,\Sigma\,\frac{B_{mn}}{n - \iota m}\sin(m\theta - [n - \iota m]\phi)$$

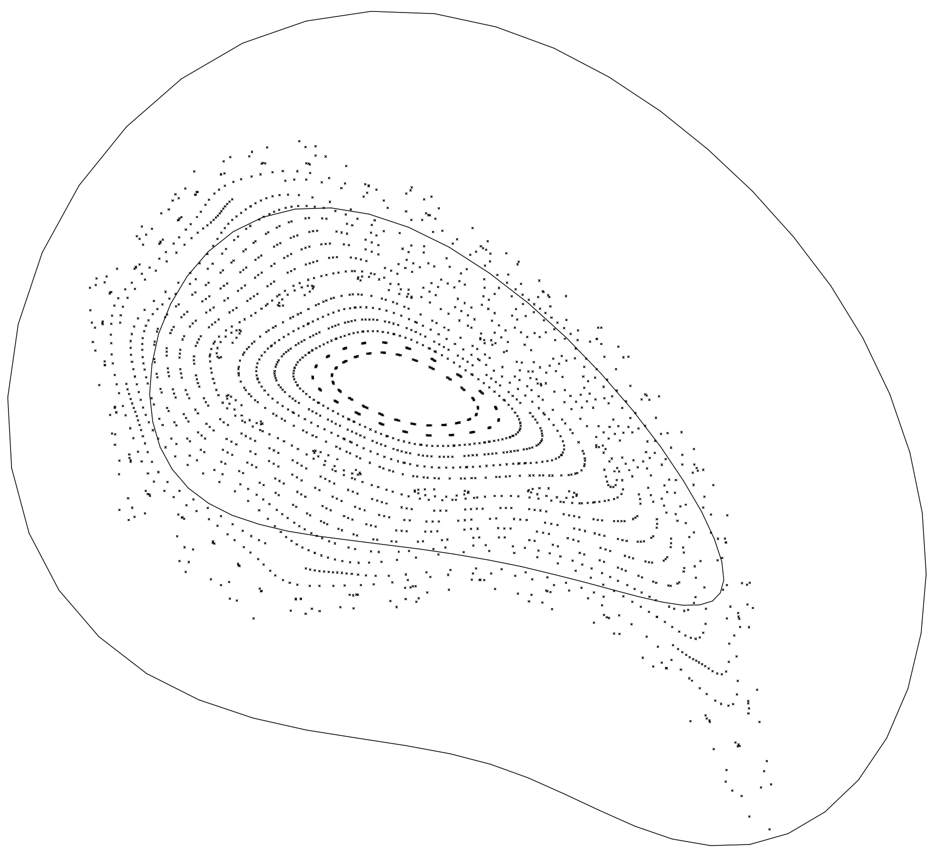
$$(\Psi_x^2)_x = \eta\,\Psi_{xxx}, \Psi(-1) = \Psi(1) = 0, \Psi_x(-1) = 1$$



Poincaré map of the flux surfaces at four cross sections over one field period of a bifurcated LHD equilibrium at $\beta = 0.04$ with the magnetic axis shifted inward to a position with major radius $R = 3.6$ m. For a broad pressure profile $p = p_0(1 - s^2)$, this exceptionally accurate solution has magnetic surfaces with ripple suggesting that it is only marginally stable. At these conditions a similar plasma was observed in the experiment.



Four cross sections of the flux surfaces over both of two field periods of a bifurcated QAS equilibrium at average $\beta = 0.06$ with pressure $p = p_0(1 - s^{1.1})^{1.1}$ and with net current bringing the rotational transform into the interval $0.65 > \iota > 0.45$. A low order ballooning mode appears in the solution, which has an obvious asymmetry.



Poincaré section of a line tracing calculation for the MHH2 stellarator displaying the control surface for the coils, the known shape of the plasma at $\beta = 0$, and magnetic lines computed in the solution, where the rotational transform lies in the range $0.48 > \iota > 0.38$ . The extent of the magnetic lines outside the separatrix shows there are favorable conditions for the construction of a divertor.