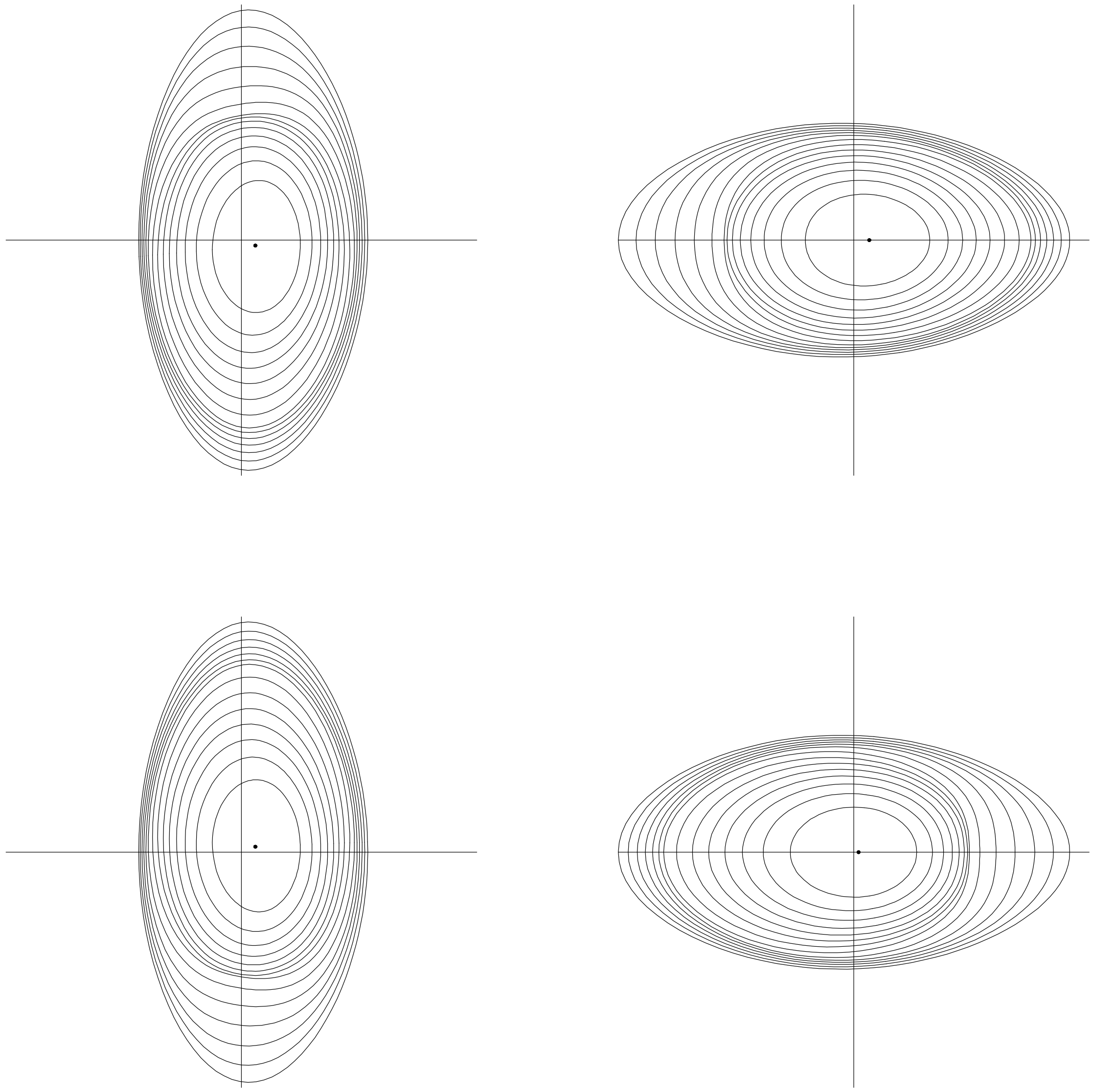
NONLINEAR MHD STABILITY OF THE LHD, W7-AS AND MHH2

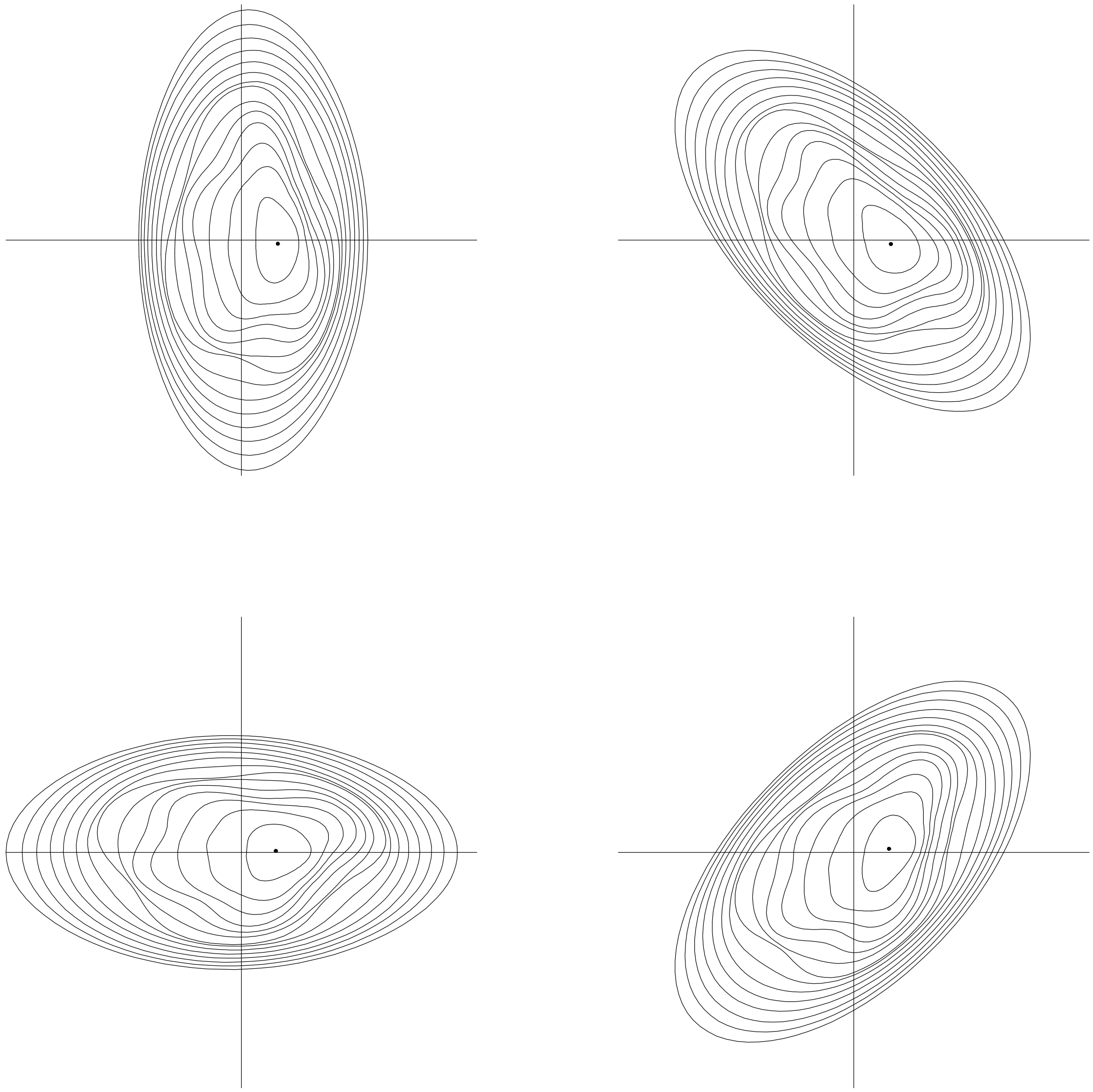
P.R. Garabedian

The NSTAB code has been run to show that the LHD stellarator is linearly unstable, but remains nonlinearly stable, at the β of 3.2% achieved experimentally. Predictions of ballooning stability for the LHD are more pessimistic than estimates from bifurcated solutions calculated over 1, 2, 5 or 10 periods. Similar results have been obtained for a W7-AS configuration.

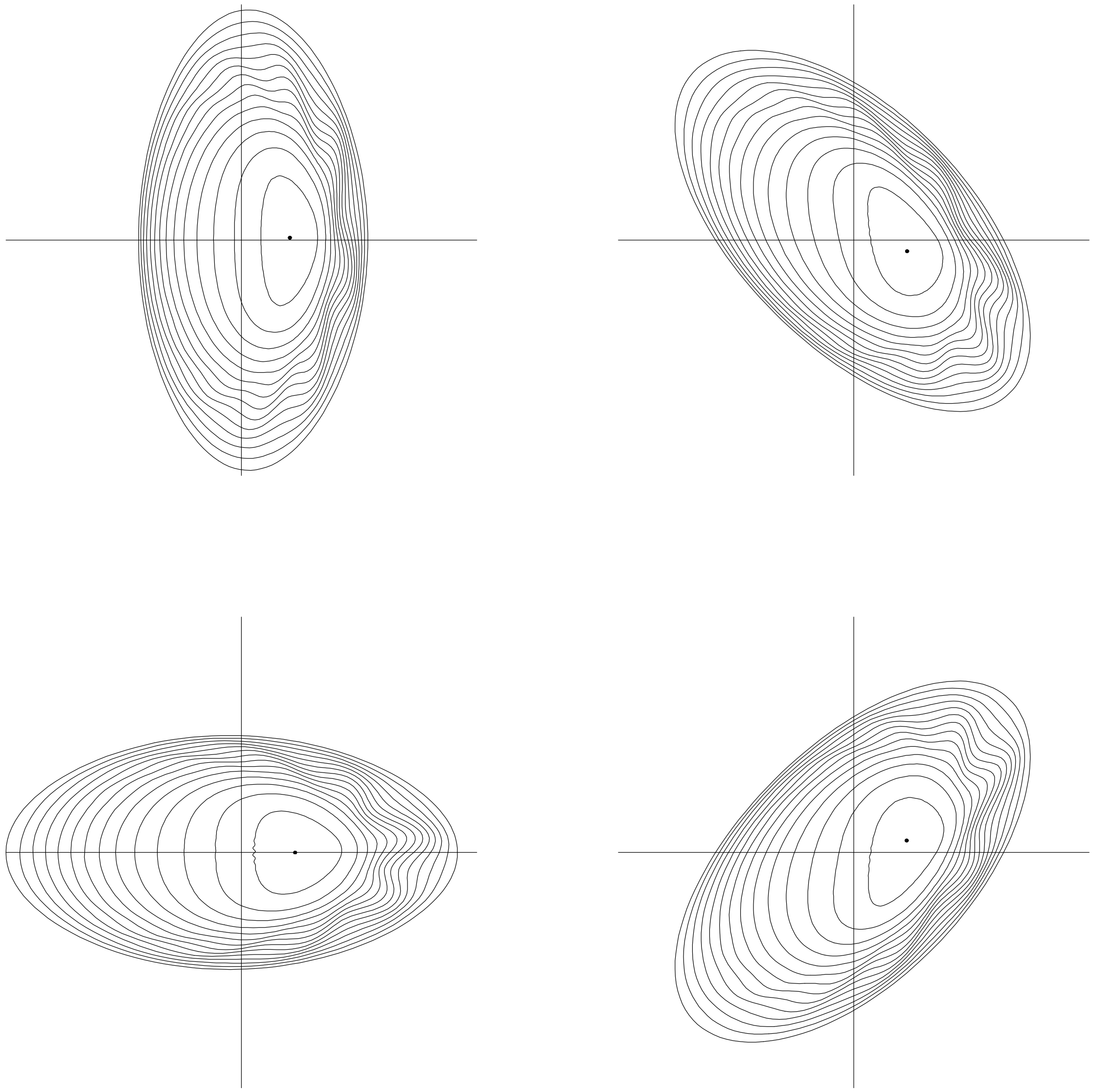
Good correlation of the computations with observations have been used to design a quasi-axially symmetric MHH2 stellarator. The β limit can be estimated by performing long, accurate runs of the NSTAB code to find out whether wall stabilized ballooning structures appear in the solution.



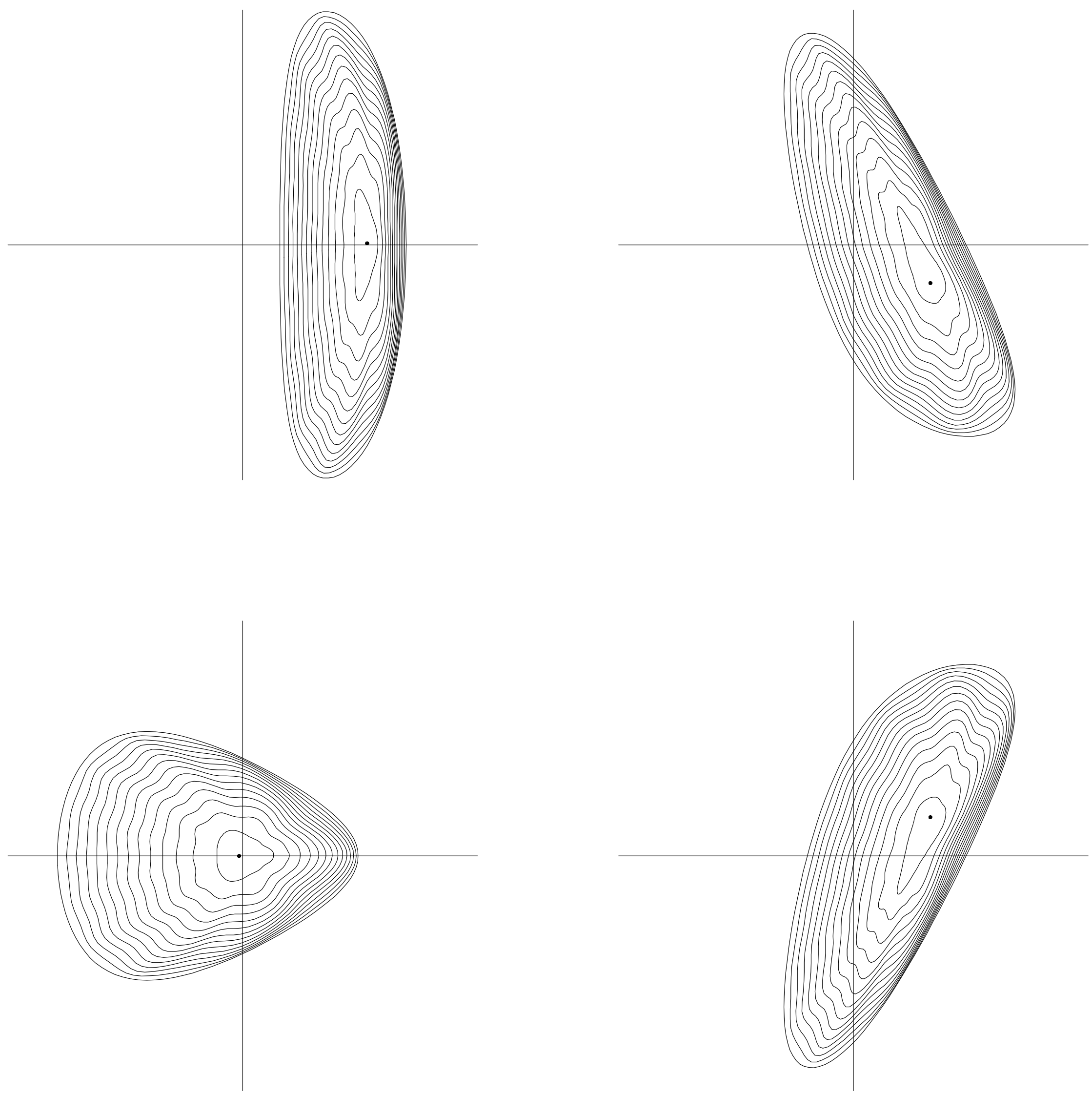
Poincaré map of the flux surfaces at four cross sections over the full torus of a bifurcated LHD equilibrium at $\beta = 0.025$ with the magnetic axis shifted inward to a position with plasma radius $R = 3.6$. For a standard pressure profile $p = p_0(1 - s)$, and with bootstrap current, the global $m = 1, n = 1$ mode of this solution is linearly unstable, but nonlinearly stable.



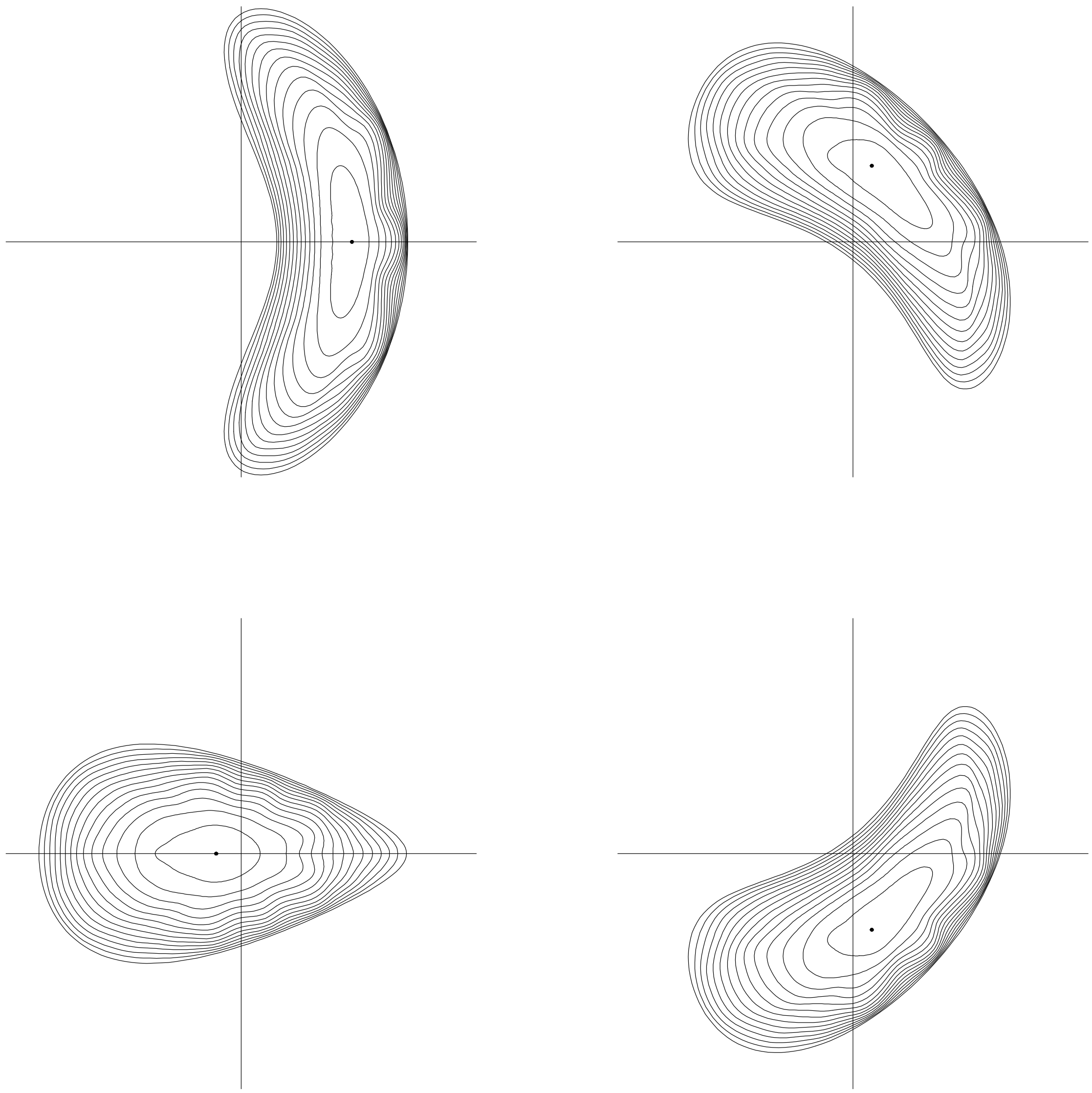
Poincaré map of the flux surfaces at four cross sections over five field periods of a bifurcated LHD equilibrium at $\beta = 0.02$ with the magnetic axis shifted inward to a position with plasma radius $R = 3.6$. For a triangular pressure profile $p = p_0(1 - s^{0.7})$ like observed values of the electron temperature, the solution is linearly unstable but nonlinearly stable.



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 plasma radius $R = 3.6$. For a standard pressure profile $p = p_0(1 - s)$, this solution developed a ballooning mode and is becoming nonlinearly unstable. The mode was stable at $\beta = 0.03$.



Four cross sections of the flux surfaces over one field period of a bifurcated W7-AS equilibrium at $\beta = 0.03$ with a pressure profile $p = p_0(1 - s)$ and with net current bringing the rotational transform into the interval $0.6 > \iota > 0.5$. At conditions related to those in the experiment an ideal MHD mode with ballooning structure appears in the calculation. After some of the net current was removed the solution became stable, which is consistent with recent obsrvations at $\beta = 0.033$.



Four cross sections of the flux surfaces over one field period of a wall stabilized MHH2 equilibrium at $\beta = 0.05$ with pressure $p = p_0(1 - s^{1.5})^{1.5}$ and with hybrid net current bringing the rotational transform into the interval $0.58 > \iota > 0.52$. The ballooning mode that has become visible in the solution after 200,000 cycles of an accelerated iteration scheme shows that a β limit has been reached.