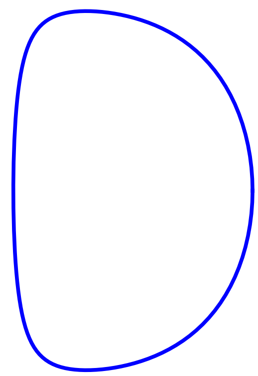
Parameterization of Tokamak Flux-Surface Equilibrium

Equilibrium force-balance in a tokamak ($\nabla p = \vec{j} \times \vec{B}$) gives rise to toroidally-symmetric magnetic flux surfaces throughout the plasma volume. The calculation of this equilibrium is routinely carried out at General Atomics using the EFIT code. The solution from EFIT is given in the form of a flux field on a two-dimensional (X, Y) mesh. This toroidal equilibrium solution is required as an input to kinetic turbulence and transport codes. However, for use in these codes, a **parameterized** form of the flux-surface geometry is required. One popular parameterization takes the form

$$X(r,\theta) = X_0(r) + r\cos\left(\theta + \delta\sin\theta\right) \ ,$$
$$Y(r,\theta) = Y_0(r) + \kappa\, r\sin\left(\theta + \zeta\sin 2\theta\right) \ ,$$



where κ, δ, ζ are the flux-surface *elongation*, *triangularity* and *squareness*, respectively. The pair (r, θ) are generalized polar coordinates. The plot to the right shows an example for $(\kappa, \delta, \zeta) = (1.5, 0.4, 0.15)$. The goal of this research project will be to explore a new, more systematic approach for this parameterization. The method will more accurately represent the flux surface geometry in the plasma edge, where the shaping is strongly non-circular and close to singular. The project will be mathematical in nature, so is suited to those with a strong background in applied mathematics. The resulting algorithm will be implemented using a combination of Fortran 2008 and Python. However, for this project, no knowledge of Fortran is required. Work will be carried out in coordination with members of the Theory and Computational Science Group at General Atomics.