Novel Designs of Quasi-Isodynamic Stellarators

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One of the main goals of stellarator optimization is the minimisation of the average radial guiding-centre drifts of particle orbits. If such drifts average to zero over time for all particles, the corresponding configuration is termed omnigeneous. Additionally, if the constant magnetic field contours close poloidally, the configuration is termed quasi-isodynamic. Compared to quasisymmetric devices, quasi-isodynamic stellarators are relatively insensitive to the plasma pressure (due to a small Shafranov shift), the bootstrap current vanishes identically at low collisionality, and quasi-isodynamic stellarators may thus be operated with essentially no net current, which significantly facilitates stellarator optimization methods. On the other hand, the construction of a numerically efficient target function for stellarator optimization seeking quasi-isodynamiticity has proven to be substantially more difficult than finding a quasisymmetric target function. In this work, we show recent results regarding novel optimization methods towards quasi-isodynamic stellarator configurations. We show that a combination of the near-axis expansion formalism and ideal MHD equilibrium solvers can be used to find quasi-isodynamic configurations with extremely low levels of neoclassical transport, lower aspect ratio, a smaller number of field periods, and a smaller number of coils than the W7-X device. These novel configurations are also shown to admit a large coil-to-plasma boundary distance. Finally, we show how the near-axis expansion method can be used to find approximate quasi-isodynamic configurations that are MHD stable using computationally inexpensive methods.