Optimizing a Quasi-helically Symmetric Stellarator

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Neoclassically-optimized stellarators offer a pathway towards three-dimensional configurations that are not susceptible to disruptions but have neoclassical transport properties similar to axisymmetric devices. The Helically Symmetric Experiment (HSX) has experimentally verified improved neoclassical confinement in a quasi-helically symmetric experiment [1]. One of the challenges facing the HSX experiment is the relatively small scale of the device and modest heating capabilities. In order to begin the discussion of a possible new stellarator experiment, we undertake optimization of a new quasi-helically symmetric configuration at larger major radius, smaller aspect ratio, higher magnetic field strength, and higher plasma β than HSX. The targets chosen included an aspect ratio of $A = 6.7$, an average major radius of $\langle R \rangle = 6.0$ m, an average magnetic field strength of 2.0 T, enhanced quasi-helical symmetry, lower neoclassical transport as estimated by the NEO code [2], ballooning stability as calculated by the COBRAVMEC code [3], and bootstrap current consistency [4] (where the plasma current matches the bootstrap current). In particular, configurations with different rotational transform profiles are explored to obtain configurations that are able to withstand the addition of bootstrap current at higher β. That is, the unwinding of the rotational transform due to bootstrap current in quasi-helical configurations does not cause low order rational surfaces to enter the plasma. A longer-term goal is to introduce alpha particle confinement into the optimization process. Full results and analysis will be presented.

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References

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