Stellarator Turbulence Optimization Based on Flux-Surface Triangularity

J. M. Duff[1], B. J. Faber[1], C. C. Hegna[1], M. J. Pueschel[2,3] and P.W. Terry[1]

[1]University of Wisconsin-Madison, Madison, WI 53706

[2]Dutch Institute for Fundamental Energy Research, 5612 AJ Eindhoven, The Netherlands

[3]Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands

Advances in stellatator optimization have been successfully leveraged to find new stellarator configurations with enhanced confinement of collisionless particle trajectories [1]. A subsequent goal of stellarator optimization is to find stellarator configurations that also reduce turbulent transport using three-dimensional (3D) shaping. Trapped electron mode (TEM) turbulence is thought to play a prominent role in the confinement properties of quasi-symmetric stellarators [2]. One method for improving the turbulent transport properties of tokamak plasmas is to appeal to negative triangularity [3]. This improvement is in part attributed to precessional drift reversal of trapped electron orbits, which has a beneficial effect on TEM turbulence [4]. In this work, we address the possibility of using negative triangularity as a mechanism to reduce TEM turbulence in stellarator plasmas. Towards this end, a new optimization framework is developed using local 3D MHD equilibrium solutions [5]. This approach has been successfully employed to improve the quasi-symmetry properties—a metric for reducing neoclassical transport—in conjunction with reducing analytic metrics designed to improve TEM stability by encouraging precessional drift reversal for a local 3D MHD equilibrium for a helically-rotating negative triangularity stellarator. The gyrokinetic code GENE is then employed to assess the local TEM linear stability characteristics of stellarator flux surfaces with varying degrees of negative triangularity. These insights help improve reduced metrics for modeling TEM turbulence [6] for use in ensuing optimization calculations.

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