The Design of Stellarators with Simple and Flexible Coils

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Stellarators are fusion devices that require careful optimization of their magnetic field equilibria to achieve high performance, which can result in complex coils. As coils are one of the main cost drivers of such devices, it is of utmost importance to shape coils that are simple enough to be economically viable, but complex enough to reproduce the target magnetic fields accurately. Typical approaches involve optimization routines that include regularization terms such as coil curvature and coil-to-coil distance. However, such approaches keep the target magnetic field fixed. A new, state-of-the-art set of methods has recently emerged that simplifies this by simultaneously optimizing both aspects, commonly called single-stage optimization methods. This work [1] shows, for the first time, the broad range of applicability of such methods by generating many configurations with either a low number of helical coils or allowing for flexible configurations that can support multiple plasma states with the same set of coils. These apply to quasisymmetric, quasi-isodynamic, or general stellarator configurations. The large set of new designs was computed using massively parallelized optimizations of stellarator equilibria.

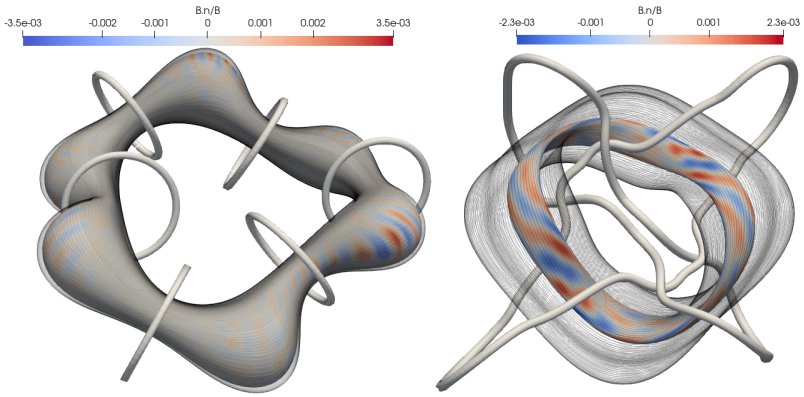

Figure 1: *Two configurations with simplified coils obtained using single-stage optimization [1].*

References

[1] R. Jorge, A. Giuliani, J. Loizu 2024. "Simplified and Flexible Coils for Stellarators using Single-Stage Optimization." arXiv:2406.07830.