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Seminar

Global, robust, multi-objective optimization of stellarators

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Abstract: A stellarator is a type of toroidal magnetic field geometry used to confine fusion-relevant plasmas. Unfortunately for applied mathematicians, physicists do not measure how good a stellarator is with a single number. Among other things, an "optimal" stellarator should approximately satisfy desirable field symmetries, satisfy macroscopic and local stability, minimize different types of transport, and minimize engineering complexity. We also want designs that are robust to small variations and do not require unrealistically tight tolerances for coil manufacturing and placement. These objectives and constraints are complicated, non-convex functions of the plasma boundary and coil shapes, and they may be subject to subtle tradeoffs.

In this talk, we describe why state-of-the-art stellarator optimization tools do not yet fully explore the range of design

tradeoffs to find robustly "optimal" designs. We discuss formulations of robust optimization and show some results achieved by members of our group in the context of stellarator optimization. We then discuss the shortcoming of the "scalarization" formulation of multi-objective optimization used in the current generation of stellarator optimizers,

showing why this approach may miss parts of the Pareto frontier of best tradeoffs. Finally, we discuss how to go beyond "black box" approaches with optimization algorithms that use both derivative information and physics-based approximations to quickly explore and converge to the globally best parts of the design space.

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