Contribution ID: **48** Type: **Poster**

A new multigrid solver for stellarator neoclassical transport

Solution of the drift kinetic equation [1] is a required step in analyzing and optimizing neoclassical transport in stellarators. A variety of codes [2-6] have been developed to handle the complex geometry and wide range of collisionality regimes present in stellarators. Existing codes are generally either high fidelity codes that are accurate in a wide range of regimes, but are too expensive to be efficiently used in optimization loops or predictive transport frameworks, or lower fidelity codes that are faster are limited in their regimes of validity or miss important physical phenomena such as the bootstrap current or ambipolar electric field. We have developed a new neoclassical code that attempts to bridge this gap, offering high fidelity solutions capturing as much of the physics as possible, while being significantly faster and more memory efficient than existing high fidelity codes. We do this by making use of novel stable finite difference discretizations combined with a multigrid method to solve the resulting linear system. Automatic differentiation is used to obtain derivatives for use in optimization. Applications are discussed including self consistent optimization of the bootstrap current and optimization of "electron root"plasmas [7].

References

[1] R. D. Hazeltine, "Recursive derivation of drift-kinetic equation,"Plasma Physics, 1973
[2] S. Hirshman, et. al. "Plasma transport co-efficients for nonsymmetric toroidal confinement systems,"The Physics of fluids, 1986.
[3] W. Kernbichler, et. al. "Recent progress in neo-2; a code for neoclassical transport computations based on field line tracing,"Plasma and Fusion Research, 2008
[4]M. Landreman, et. al. "Comparison of particle trajectories and collision operators for collisional transport in nonaxisymmetric plasmas,"Physics of Plasmas, 2014
[5] J. L. Velasco, et. al. "Knosos: A fast orbit-averaging neo- classical code for stellarator geometry,"Journal of Computational Physics, 2020
[6] Escoto, F. J., et al. "MONKES: a fast neoclassical code for the evaluation of monoenergetic transport coefficients in stellarator plasmas." Nuclear Fusion, 2024
[7] Neto, E. Lascas, et al. "Electron root optimisation for stellarator reactor designs." Journal of Plasma Physics, 2025

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Session Classification: Poster Session #2