

# Confinement in stellarators with the global gyrokinetic code XGC

Thursday 25 October 2018 14:00 (20 minutes)

Whole-volume gyrokinetic simulations of stellarators are necessary to address a number of important physics and engineering issues, including energetic particle confinement optimisation and turbulent transport prediction. In recent work, a whole-volume stellarator version of the global gyrokinetic Particle-In-Cell (PIC) code XGC[1] is under development. A 3D interpolation of equilibrium magnetic field to the last closed flux surface, calculated using the VMEC MHD equilibrium code, has been implemented, along with a 3D mesh for calculating the evolution of the electrostatic potential.

The 3D version of XGC has been successfully benchmarked with the NBI code BEAMS3D[2] and the core 3D gyrokinetic code EUTERPE[3] for energetic particle orbit tracing in Wendelstein 7-X (W7-X) geometry. It has been used to investigate collisionless alpha particle confinement in potential stellarator reactor designs. The new tool permits direct comparison for alpha particle loss between quasi-axisymmetric and quasi-isodynamic designs.

Furthermore, microturbulence has been observed in the outer portion of the core, and in the edge, of the W7-AS stellarator[4], and is likely to dominate in this region of Wendelstein 7-X or any stellarator reactor. Developments to the XGC code will permit 3D global simulation of ion-scale turbulence in stellarators, which has so far not been achieved. By simulating first the linear stage of the Ion Temperature Gradient-driven (ITG) instability, and then nonlinear turbulence, XGC will be applied to better understand the global behaviour of turbulence in the Wendelstein 7-X stellarator.

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## Country or International Organization

United States of America

## Paper Number

TH/P6-21

**Author:** Dr COLE, Michael (Princeton Plasma Physics Laboratory)

**Co-authors:** Dr CHANG, Choong-Seock (Princeton Plasma Physics Laboratory and KAIST); Dr HAGER, Robert (Princeton Plasma Physics Laboratory); Dr LAZERSON, Samuel (Princeton Plasma Physics Laboratory); Dr KU, Seung-Hoe (Princeton Plasma Physics Laboratory); Dr MORITAKA, Toseo (National Institute for Fusion Science)

**Presenter:** Dr COLE, Michael (Princeton Plasma Physics Laboratory)

**Session Classification:** P6 Posters