Development of a First-Principles Simulation Model of Turbulent Transport in Compact Tori

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Understanding particle and energy transport in field-reversed configuration (FRC) plasmas is a crucial step towards an FRC-based fusion reactor. Operational mastery of the advanced beam-driven FRC devices, C-2 and C-2U, at Tri Alpha Energy, Inc. (TAE), has achieved macroscopically stable plasmas^[1], leading to experimental and theoretical investigation of transport scaling^{[2],[3],[4]}. Electron energy confinement time in C-2U increased with electron temperature^[1]. Similarly favorable scalings have been seen in spherical tokamaks^{[5],[6]}. A primary objective of TAE's upcoming C-2W device, scheduled to begin experiments in mid-2017, is to explore this scaling in an extended parameter regime.

Concurrently, substantial progress has been made on developing a turbulent transport model for high- β compact tori (CT). In this work, progress on this model development within two codes, the Gyrokinetic Toroidal Code (GTC) and A New Code (ANC), is reported. Recent features added to the GTC suite, including a general implementation of cross-separatrix geometry, are discussed. ANC is introduced as an electrostatic, nonlinear, particle-in-cell, microturbulence code, with modular gyro-kinetic (GK) or FK particles, tailored for FRC geometry. GK and FK verification benchmarks are presented, along with early validation of global linear and non-linear simulations against measurements in C-2U. Future development of GTC and ANC will be addressed, along with plans for code validation against both C-2W and NSTX-U.

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