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Full Radius Electromagnetic Gyrokinetic Code: Flux Tube Operation

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We describe work in progress to formulate a general geometry full radius nonlinear electromagnetic gyrokinetic code (GYRO) to simulate high-n turbulence and transport in tokamaks. The code employs continuum (fluid-like) methods in a five-dimensional grid space. The code will ultimately have three modes of operation: (1) flux tube with periodic radial boundary condition (*i.e.*, a high-n ballooning mode representation with $\Delta n \approx 10$); (2) a full radius wedge code ($\Delta n \approx 10$) to study profiles shear effects; and (3) a full torus ($\Delta n = 1$) code to study coupling to low-n MHD. The grid layout uses a Fourier transform (with toroidal mode numbers n) of the a field line following angle (α), a physical poloidal angle (θ), and a minor radius (r) with an energy (ε) and pitch angle ($\lambda = \mu/\varepsilon$) velocity phase space. Real geometry is formulated with Miller's generalized s–α local equilibrium [1]. Time split methods are used with the fast parallel motions (particularly for electrons) handled implicitly and subcycle explicit methods for the slower cross field linear and nonlinear motions. Presently we have successful linear and nonlinear operations of the flux tube limit with good benchmark comparisons to the radial Fourier transform GS2 code from Dorland *et al.* [2]. MPI parallel process methods are used with good performance on 16 and 45 processor Beowulf LINUX clusters at GA and on the NERSC T3E (see companion poster by Candy). Methods for full radius wedge tube operation will be discussed.

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[1] R.L. Miller, M.S. Chu, J.M. Greene, Y.R. Lin-Liu, and R.E. Waltz, Phys. Plasmas **5**, 973 (1998).

[2] W. Dorland, F. Jenko, M. Kotschenreuther, and B. Rogers, submitted to Phys. Rev. Lett.