AN EXPLICIT, NONPERIODIC, NONLINEAR EULERIAN GYROKINETIC SOLVER FOR MICROTURBULENCE SIMULATION*

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The General Atomics gyrokinetic-Maxwell solver (GYRO) has been largely rewritten replacing implicit but split time steps with explicit high order steps. An orbit-time grid replaces the more familiar fixed poloidal grid in the kinetic equation, allowing full resolution of bounce-point cusps. More systematic, high-accuracy quadrature rules yield superior convergence with number of velocity-space points. Velocity integrals themselves are projected onto a set of poloidal “blending”-functions to obtain the theta-dependence of fields. The full nonlinear equations (including zonal flows) are advanced in time using a fourth-order integrator. These changes were motivated to overcome the unacceptably poor time-step convergence of nonlinear operator splitting methods.

The code is parallelized using a more efficient domain decomposition algorithm than that in GYRO, making it suitable for MPP simulation with greater than 10^3 processors. We can compute linear ballooning-modes to high accuracy with surprisingly small phase-space grids, and can reproduce CYCLONE ITG diffusivities with timesteps on the order of $(c_s/a)\, dt = 0.1$. We intend to study systematically how transport properties are modified when density and temperature profiles are allowed to vary in the simulation domain. Also, we revisit problems which have received little attention in the past – such as Landau damping of geodesic acoustic modes (n=0), and linear dynamics of the gyrokinetic equations in profile-sheared equilibria (n > 0). Presentation of this work is highlighted by exhaustive MPEG animation of linear and nonlinear simulations. We believe this will be of interest to experimentalists as well as theorists.

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