An Explicit, Nonperiodic, Nonlinear Eulerian Gyrokinetic Solver for Microturbulence Studies

J. Candy, R.E. Waltz, M.N. Rosenbluth
General Atomics

The General Atomics gyrokinetic-Maxwell solver (GYRO) – which relied on an implicit parallel motion advance with operator splitting for nonlinear terms – has been largely rewritten. In the new code, eGYRO, an orbit-time grid replaces the more familiar fixed poloidal grid in the gyrokinetic 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 in the Maxwell equations 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 an explicit 4th-order integrator. These changes were motivated to overcome the unacceptably poor time-step convergence of semi-implicit splitting methods, and to more elegantly treat nonperiodic radial boundary conditions.

eGYRO 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. Linear ballooning modes can be computed rapidly and with high accuracy using suprisingly small phase-space grids. CYCLONE ITG benchmark cases are reproduced with timesteps on the order of $(c_s/a)dt = 0.1$. Moving beyond periodic radial boundary conditions, we examine systematically the modification of transport properties when density and temperature profiles vary within the simulation domain. Presentation of this work is highlighted by exhaustive MPEG animation of linear and nonlinear simulations. The scope of the presentation will be broadened by an intuitive, nontechnical component, which we hope will make it equally appealing to experimentalists and theoretists.

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