Electromagnetic Gyrokinetic Microturbulence: Simulation and Visualization*

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The General Atomics gyrokinetic-Maxwell solver (GYRO) has matured into a comprehensive tool for the study of tokamak microturbulence. Numerous algorithmic innovations in combination with a zero-noise Eulerian grid allow the global study of electromagnetic turbulence in shaped plasmas with fully kinetic trapped and passing electron dynamics (no fluid approximation). In the simple case where electrons are taken to be adiabatic, high-resolution nonlinear simulations with realistic geometry and profiles – including equilibrium rotation – can be made in about an hour on 32 IBM-SP processors (this is at least ten times faster than cases with full electron dynamics). Using GYRO, we have recently been able to demonstrate and explain from first principles the mechanism for the breaking of gyroBohm scaling, as well as the dynamics of transport reduction by equilibrium flows. The success of this research programme was facilitated in large part by use of an IDL-based visualization tool (vuGYRO) for diagnosis, animation and exploration of simulation results.

In this presentation, we explore state-of-the-art physics results obtained from GYRO with a next-generation suite of visualization tools based on the open-source Visualization ToolKit (VTK). This suite of C++ classes provides an interface for sophisticated surface and volume rendering in general toroidal geometry. Using this new suite of tools, we can generate isosurfaces of not only the electrostatic and electromagnetic potentials, but for the first time can show (i) local density and temperature fluctuations; (ii) E×B motion; and (iii) transport flows (volume dependence of local fluxes). We are also interested in elucidating the role, if any, of so-called "avalanche" effects in the generation of radial transport. The presentation, which summarizes the core of our new physics results, will consist primarily of MPEG movies of the time-evolution of the isosurface functions described above. For this reason, we hope it will be of interest to experts and nonexperts alike.

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