COMPUTATIONAL RESEARCH in BOSTON and BEYOND SEMINAR

Electromagnetic gyrokinetic turbulence simulations in the tokamak edge with discontinuous Galerkin methods

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ABSTRACT:

Gkeyll, a full-F continuum gyrokinetic code, is being developed to study plasma turbulence in the edge and scrape-off-layer (SOL) region of fusion devices. This region involves large-amplitude fluctuations, electromagnetic effects, and plasma interactions with material walls due to open magnetic field lines; all of these effects make the edge more computationally challenging than the core region. Gkeyll models the turbulence by solving the 5-D full-F gyrokinetic system in Hamiltonian form using an energy-conserving high-order discontinuous Galerkin (DG) scheme. I will present new simulations that self-consistently include the effects of electromagnetic fluctuations of the background magnetic field on the turbulence in the SOL. These simulations are the first continuum gyrokinetic simulations on open field lines to include electromagnetic effects.

I will also present some of the implementation details of the DG scheme in Gkeyll. We choose a modal basis composed of orthonormalized Serendipity polynomials, which makes tensor products sparse. We use a computer algebra system (like Mathematica) to compute the (sparse) tensor products in the DG weak form of the gyrokinetic equation. This system then generates the solver kernels that form the back end of Gkeyll: thousands of lines of machine-written C code containing no loops. This allows our algorithm to be able to take full advantage of the sparsity, and it also makes the implementation quadrature-free. The result is an O(10) speed-up over a previous implementation which used a nodal Serendipity basis with Gaussian quadrature.

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Building 36, Room 462
50 Vassar Street – Cambridge, MA

Pizza and beverages will be provided.

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