

Porting and Performance of Spectral Gyrokinetics on NVIDIA, AMD and Intel GPU architectures

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Spectral Gyrokinetics (SGK) refers to the use of spectral numerical methods for discretizing the 5-D gyrokinetic-Maxwell equations in toroidal geometry. The allure of this approach is the rapid convergence of solutions with grid refinement, as well as heavy reliance on dense linear algebra and FFTs which can exploit GPU capability. This presentation will focus on a particular formulation of SGK used in the General Atomics CGYRO code, as well as the generalization to global effects without sacrificing performance. We will detail the challenges involved in porting to NVIDIA, AMD and most recently Intel HPC systems. SGK methods in CGYRO shine for simulations with extreme scale separation in space and time. With the advent of the Frontier supercomputer at ORNL, exascale CGYRO simulations have become increasingly routine, and allow detailed exploration of subtle tokamak transport mechanisms relevant for burning plasma regimes.