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Continuum Electromagnetic Gyrokinetic Simulations of Turbulence in the Tokamak Scrape-Off Layer and Laboratory Devices[1]

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We present results from Gkeyll, a full-F continuum, electromagnetic gyrokinetic code, designed to study turbulence in the edge region of fusion devices. The edge is computationally very challenging, requiring robust algorithms that can handle large amplitude fluctuations and stable interactions with plasma sheaths. We designed an energy conserving high-order discontinuous Galerkin scheme that solves gyrokinetic equations in Hamiltonian form. Efficiency is improved by a careful choice of basis functions and automatically generated computation kernels. Model sheath boundary conditions are used that allow current to flow into/out of the wall. Verification tests were performed in the straight field-line LAPD device[1] and the simple magnetized torus Texas Helimak[3], including the effect of end-plate biasing on turbulence. Results for the scrape-off layer (SOL) for NSTX parameters with a model helical magnetic geometry with bad curvature have been obtained[2], and extended to include electromagnetic fluctuations using a symplectic $(v)_{||})$ formulation[4]. Parameter scans show the scaling of amplitude and intermittency of SOL turbulence and the resulting divertor plate heat-flux width. The code has recently been extended to a general geometry SOL. A version of the code for full Vlasov-Maxwell equations [5,6] has been developed (for applications such as the solar wind, Hall thrusters, and laser-produced plasmas). Results for magnetic field amplification from Weibel instability will be briefly described[7]. [1] Shi, E. L. et al., 2017 J. Plasma Phys. 83, 905830304 [2] Shi, E. L. et al., 2019 Phys. Plasmas 26 , 012307 [3] Bernard, T. N. et al. 2019 Phys. Plasmas 26, 042301 [4] Mandell, N.R. et al., 2019 arXiv. [5] Juno, J. et al., 2018 JCP 353, 110 [6] Hakim, A. Francisquez, M., Juno. J, Hammett G.W. 2019, arXiv:1903.08062. [7] Skoutnev, V. et al. 2019 Ap. J. Lett. 872, L28

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