Application of the Spectral Element Code (SEL) to Edge Plasma Modeling*

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Abstract

SEL [1] is a new massively-parallel implicit spectral element [2,3] code for macroscopic multidimensional modeling of magnetized plasma being developed at Los Alamos National Laboratory. It uses high-order spectral elements on a logically rectangular grid for spatial discretization and second-order adaptive implicit Newton-Krylov method for time-advancing. In this work a 2D version of SEL is used to solve a new system of drift-ordered short mean-free path two-fluid equations [4] to model a highly-turbulent plasma evolution in linear devices. This serves as the initial step towards using a 3D version of SEL with equations [4] for modeling tokamak edge plasma turbulence in a realistic geometry. Continuity, parallel Ohm's law, parallel total momentum, vorticity, electron and ion energy equations supplemented by equations for perturbed magnetic and electric fields are solved in a circular or annular domain with normal to it equilibrium magnetic field, which represents a linear machine cross-section. Interchange modes are considered. The linear stability is benchmarked against numerical solutions of the corresponding radial Sturm-Liouville problem. Formation of plasma "blobs" in the "bulk" plasma, their peeling off at the "separatrix" and radial propagation towards the wall due to the effects of "neutral wind" in the "scrape-off" layer [5] is studied.

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