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A multigrid method for drift-kinetic calculations in stellarators and rippled tokamaks[1] MATT LANDREMAN, University of Maryland, HÅKAN SMITH, IPP-Greifswald — Important phenomena such as the bootstrap current and collisional transport in stellarators, and neoclassical toroidal viscosity in tokamaks, must be computed by numerical solution of the drift-kinetic equation in nonaxisymmetric geometry. This equation has the form of a linear, inhomogeneous, advection-dominated advection-diffusion PDE with recirculating flow, internal boundary layers, and a null space, with typically five coupled dimensions (poloidal and toroidal angle, speed, velocity pitch angle, and species.) While multigrid algorithms are a preferred method for efficient solution of some PDEs, multigrid smoothers are typically unstable for accurate discretizations of the drift-kinetic equation due to the absence of any physical diffusion in the spatial dimensions, and the dominance of advection over diffusion in the velocity dimensions. In this work we demonstrate a high-order-accurate multigrid solution of the drift-kinetic equation in nonaxisymmetric geometry. A defect correction approach is used: solution of a high-order discretized problem is preconditioned by a multigrid cycle in which a low-order upwinded discretization is used for smoothing. Compared to a direct solver, the multigrid method can reduce the memory requirement by several orders of magnitude.

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