High-order, Mapped-multiblock, Finite-volume Discretization of Gyrokinetic Systems Near the X Point of a Diverted Tokamak Geometry

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Abstract

We report our progress in the development of high-order, finite-volume discretizations in mapped-multiblock coordinate systems. Our motivating application is the solution of gyrokinetic systems modeling edge plasma evolution in tokamak fusion reactors, where the use of computational coordinates aligned with magnetic field lines is highly advantageous in accommodating strong anisotropy. In computational domains obtained as a poloidal slice of an axisymmetric diverter geometry, such as that specified in the design of ITER, the so-called X point is located where the separatrix between the closed and open field lines intersects itself and the poloidal component of the magnetic field vanishes. Approaching the X point, the axisymmetric projection of magnetic field lines onto a poloidal slice become increasingly kinked, resulting in problematic large derivatives in field-aligned coordinate mappings. We describe our solution of this problem in the context of our general methodology for high-order, mapped-multiblock, finite volume discretization, and we present results obtained using our COGENT gyrokinetic edge plasma test code.