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Continuum Kinetic Modeling of the Tokamak Plasma Edge[1]

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The problem of edge plasma transport provides substantial challenges for analytical or numerical analysis due to (a) complex magnetic geometry including both open and closed magnetic field lines **B**, (b) steep radial gradients comparable to ion drift-orbit excursions, and (c) a variation in the collision mean-free path along **B** from long to short compared to the magnetic connection length. Here, the first 4D continuum drift-kinetic transport simulations that span the magnetic separatrix of a tokamak are presented, motivated in part by the success of continuum kinetic codes for core physics and in part by the potential for high accuracy. The calculations include fully-nonlinear Fokker-Plank collisions and electrostatic potential variations. The problem of intrinsic toroidal rotation driven by ion orbit loss is addressed in detail. The code, COGENT, developed by the Edge Simulation Laboratory collaboration, is distinguished by a fourth-order finite-volume discretization combined with mapped multiblock grid technology to handle the strong anisotropy of plasma transport and the complex magnetic X-point divertor geometry with high accuracy. Previously, successful performance of high-order algorithms has been demonstrated in a simpler closed magnetic-flux-surface geometry for the problems of neoclassical transport and collisionless relaxation of geodesic acoustic modes in a tokamak pedestal, including the effects of a strong radial electric field under H-mode conditions.

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