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Transport of perpendicular momentum across the last closed surface

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Edge turbulence transports plasma momentum across the last closed flux surface away from the core region towards the wall, and hence provides a momentum “source” that can induce net plasma rotation as well as sheared flows in the edge. Here we consider the transport of the perpendicular (approximately poloidal) component of momentum by drift-interchange turbulence and blobs[1,2]. As pointed out by Coppi,[3,4] blob momentum transport processes for the toroidal component are also of interest for the theory of spontaneous rotation in tokamaks, however we do not directly address the toroidal problem here. In the present paper, numerical simulations are described which use a minimal two-dimensional model, in the plane perpendicular to the magnetic field, incorporating directionality (drift-waves), radial transport (Reynolds stress and blobs), and dissipation (sheath loss terms).[5] A zonally-averaged momentum conservation law is used to advance the zonal flows. The net momentum transferred to the core is shown to be influenced by a number of physical effects: dissipation, the competition between momentum transport by Reynolds stress and passive convection by particles, intermittency (the role of blobs carrying momentum), and velocity shear regulation of turbulence. It is shown that the edge momentum source adjusts to match the rate of momentum transfer into the core, keeping the edge velocity shear nearly constant. The simulation results are also compared with the predictions of quasilinear theory.

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