The stabilizing effects of the radial electric field on H-mode edge plasmas

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The radial electric field (Er) is believed to have a stabilizing effect for tokamak turbulence. While is is true at the core, in recent gyrokinetic simulations we find that the Er stabilizing effect is rather small at the edge. In the gyrokientic electromagnetic particle code GEM, the poloidal flow was assumed to be zero by introducing a parallel flow. However, recent experiments show that the poloidal flow could be important [B.A. Grierson et al., Nucl. Fusion 53 (2013) 063010]. In this study, we apply a more complete implementation of Er following the procedures of Sugama and Horton [H. Sugama and W. Horton, Phys. Plasmas 5, 2560 (1998)]. Full main ion rotation flows are included and the effects of the centrifugal and Coriolis terms are discussed. The effects to the growth rate and Doppler shift of all terms in the force balance equation are demonstrated using global simulations of edge and core tokamak plasmas. The Er has little effect on the growth rate of edge instabilities, and this is likely due to the location of its "well", at which the shear is zero. Electromagnetic effects and nonlinear saturation mechanism are discussed. Furthermore, we have compared the Er effects at different stages of the ELM cycle.