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A five-field model of Peeling-Ballooning modes with BOUT++[1]

T. XIA, IPPCAS/LLNL, X.Q. XU, LLNL, J. LI, IPPCAS — We extend the previous two-fluid 3-field ELM simulation model[2] by separating the total pressure into density n_0, ion and electron temperature (T_{e0}, T_{i0}) equations. With diamagnetic drift, the growth rate is inversely proportional to n_0 because the diamagnetic drift is inversely proportional to n_0. The diamagnetic drift plays as the role of a threshold of the perturbation growth. Only the perturbations with the growth rate higher than this threshold can survive and begin to grow. Therefore, as density increases, the diamagnetic drift decreases and the stabilizing effect reduces as well. The diamagnetic drift is also proportional to toroidal mode number n, so at high n case, the peeling-ballooning mode is stabled by diamagnetic drift. For the same pressure profile, constant T_0 case increases the growth rate by 6.2% compared with constant n_0 case in ideal MHD model. With diamagnetic effects, the growth is increased by 31.43% for toroidal mode number n=15. This is because that the gradient of n_0 introduces the cross term in the definition of vorticity. This cross term has the destabilizing effect on peeling-ballooning mode. For the nonlinear simulation, the gradient of n_0 in the pedestal region can increase the energy loss of ELMs and drive the perturbation to go into the core region. The effects of parallel thermal conductivity will stabilize the growth of the turbulence and decrease the energy loss in the pedestal region.

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[2]X.Q.Xu, et. al., PRL, VOL. 105, 175005 (2010).

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