Study of the effect of the helical ripple on the confinement via zonal flows in helical plasmas

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The control of zonal flows is the key issue in fusion research. There has been much progress of the experiments on zonal flows [1]. A number of the calculations have been done and shown the significance of the nonlinear interaction between zonal flows and the turbulence driven by the drift wave (e.g., [2]), suggesting the new framework in the simulations of plasma transport. Based on this paradigm, we have examined the reduction of the anomalous transport due to the excitation of zonal flows by the transport code analysis in the core region [3]. The electron Internal Transport Barrier (e-ITB) in helical plasmas was shown to be formed by the mechanisms of (i) the bifurcation of the ambipolar electric field and the reduction of the neoclassical energy transport, (ii) the formation of the electric field interface which quenches the turbulence due to the shear of the electric field and (iii) the reduced damping of zonal flows which causes the suppression of the turbulent transport. The transport reduction can be obtained in a wide region for E_r in conjunction with the e-ITB. This shows that the change of the collisional damping of zonal flows can cause the transition in the turbulent transport. In the collisionless plasmas of the Large Helical Device (LHD) (in the region of the negative electric field), if the helical ripple becomes smaller, the level of the anomalous transport gets lower. We focus on the effect of the helical ripple related with zonal flows on the confinement in the helical plasmas. The reduction of the effective helical ripple causes the smaller damping rate of zonal flows in the helical plasmas even in the branch of the ion root, which means that the reduction of the anomalous transport can be obtained. For the cases of the different values for the helical ripple, the calculation results including the effects of zonal flows will be shown. This study is to investigate the impact of shifting axis positions, because the value of the helical ripple changes due to the variation of the experimental magnetic axis positions in LHD. This calculation result will explain the observations on LHD. We adopt the calculation scheme which was reported in [4], in analyzing the tranport model equations. This approach enables to reduce the iterations of calculations to obtain a conveged solution with the steep gradient of the diffusivity.

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