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内部輸送障壁形成に対する弱磁気シア効果
Weak magnetic shear effect on internal transport barrier formation

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Profile stiffness is a long standing problem, which may limit the overall performance of H-mode plasmas. In the JET experiment, while strong ion temperature profile stiffness is observed around the nonlinear threshold of ion temperature gradient, it can be greatly reduced by co-current Neutral Beam Injections (NBIs) in weak magnetic shear plasma [1]. NBIs can provide two possible stabilization mechanism of toroidal Ion Temperature Gradient (ITG) mode. One is the electromagnetic stabilization by fast ions and the other is the stabilization by toroidal rotation shear. Indeed, the latter can be decomposed into stabilizing effect of $\mathbf{E}\times\mathbf{B}$ flow shear and destabilizing effect of parallel velocity shear, which often cancel with each other. However, most previous studies are based on local gyrokinetic theory, in which global effects such as radial mean electric field and profile shear effects are not fully taken into account.

For the comprehensive study of such toroidal rotation effects, we performed flux-driven ITG simulation with momentum source by means of our full-f toroidal gyrokinetic code GKNET. We found that toroidal momentum injection can change the mean E_r through the radial force balance, leading to Internal Transport Barrier (ITB) formation in which the ion thermal diffusivity decreases to the neoclassical transport level [2].

In this study, we investigate the impact of weak or reversed magnetic shear on ITB formation by toroidal momentum injection. Figure 1 shows the radial ion temperature profile at different times in reversed magnetic shear plasma. It is found that ITB is not created around momentum source region ($0 < r < 0.4a$), because the momentum diffusion is enhanced in negative magnetic shear region ($0 < r < 0.6a$) following to the momentum transport theory [3]. On the other hand, once momentum diffusion reaches to q_{min} surface ($r = 0.6a$), it is blocked by momentum pinch from positive magnetic shear region ($r > 0.6a$). As a result, steep $U_{\parallel}$ and E_r shears are formed around q_{min}, which is considered to trigger ITB formation. This indicates that the position of ITB is insensitive to the momentum source profile, which is determined only by the q_{min} surface. These results show a qualitative agreement with the observations in the JT-60U reversed shear discharges [4].

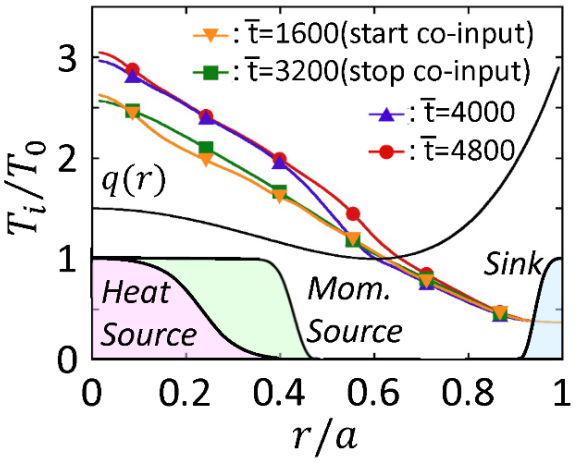

Fig. 1: *Radial ion temperature profile at different four times in reversed magnetic shear plasma.*

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Reference

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