MHD stability due to internal transport barrier and its effect on the transport

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The advanced tokamak plasma has strongly coupling of physical-factors with widely different time scales (10^{-10} to 10^{3} sec) and different spatial scales (10^{-6} to 10^{2} m), such as transport, magnetohydrodynamics (MHD), wave-particle interaction, plasma-wall interaction, and so on. These make the complexity and autonomy of plasmas. Therefore, it is a crucial issue to clarify these complex plasmas and to control the autonomous plasma in the advanced tokamak. Modeling of each physical factor and an integration of models are useful to understand the complex plasma and to control the autonomous plasma. Our strategy is to construct theoretical models and to integrate the models based on the validation of fundamental researches of JT-60U experiments and the first principle simulations.

The integrated code TOPICS-IB [1,2] is being developed, which is based on the 1.5D core transport code TOPICS extended to the integrated simulation for burning plasmas. For the analysis of ELM behaviours, TOPICS-IB [3] has a dynamic five-point model for SOL-divertor plasmas and a stability code for peeling-ballooning modes, MARG2D [4]. By using TOPICS-IB, the ELM energy loss has been analyzed and the energy loss mechanism has been clarified [3].

We investigate the property of MHD stability by using the integrated code TOPICS-IB with the stability code MARG2D, such as an effect of the local steep pressure gradient at the internal transport barrier on the localization of the eigenfunction and the toroidal mode number of the unstable mode, and we investigate how the MHD instability affects the plasma confinement. Also, the dynamic behaviours after the collapse by the MHD instability are simulated, and the sustainment of the advanced tokamak plasma is discussed.

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