§19. Possibility of Electric Bifurcation and Internal Transport Barrier Formation in LHD Plasma

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In the last two decades, various types of improved confinement states have been identified in tokamaks. Among the various of improved confinement modes, the H-mode has been studied most thoroughly. The electric bifurcation model has been proposed to explain the physics of the H-mode, and the role of radial electric field structure on various improved confinement modes has been widely recognized.

In high temperature plasmas which are confined in CHS and LHD, anomalous energy transport dominates over the neoclassical energy transport. The improved energy confinement, if it exist, could be realized when the anomalous transport is suppressed. A possibility of existence of internal transport barrier has been theoretically predicted; the electric field domain interface could be established, and transport reduction at the interface takes place. The electric field domain interface has been identified in CHS plasma, and the internal transport barrier has been found in the CHS plasma. These developments of confinement theory and experiment strongly suggest the possibility of existence of internal transport barrier in the LHD plasma. We here study a condition for the electric field domain interface to appear in the LHD plasma. On the parameter space of temperature and density, the region is identified for the presence of electric field domain interface.

The objective of the present study is to provide an analytical insight , i.e., the level of comparison with CHS plasmas, so that a simplified theoretical model is used. The model Heliotron/ Torsatron configuration is employed, in which the magnetic field is characterized by the single helical ripple and toroidal ripple. Also, we choose the profiles for temperature and density as parabolic.

The region of multiple solutions is searched for in the parameter space of ($n(0)$, $T_e(0)$, $T_i(0)$). Figure1 illustrates regions of radial electric field structures. There are three characteristic regions in this diagram; the region of electron root, multiple solutions, and ion root. Figure 2 shows the electric field structure on the ($T_e(0)$, $T_i(0)$) plane for the fixed density.

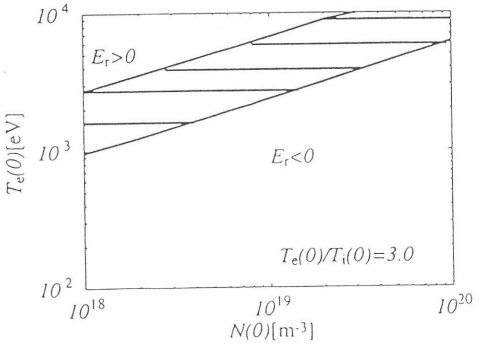

Fig. 1 Regions of the multiple electric solutions, electron root, and ion root in LHD plasma.

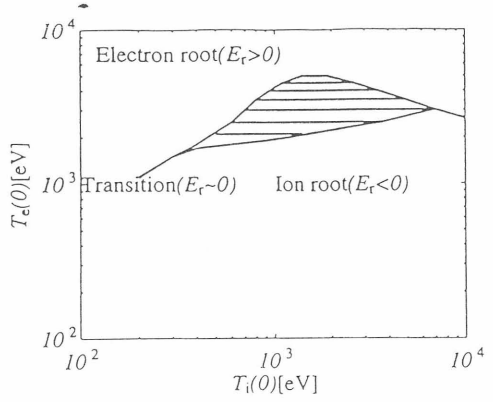

Fig.2 Regions of the multiple electric solutions, electron root, and ion root for fixed density.