# §12. MHD Activities Destabilized in the Stochastic Region of the Large Helical Device

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MHD activities in the region where the magnetic flux surfaces are partially disturbed by the externally applied field are now extensively studied in the context of the physics of ELM mitigation[1)]. Topologically similar magnetic stochastic region is also formed naturally in the peripheral region of LHD. Though, in 3D helical systems, the existence of the closed magnetic flux surface is not mathematically guaranteed, the formation of the closed flux surface-like region is confirmed by the vacuum magnetic field line tracing. Outside this closed regions, there are so-called magnetic stochastic region, where the connection length to the wall is short, e.g., several tens / hundreds of meter. In finite beta conditions, a 3D equilibrium code HINT2 is used for the equilibrium estimation. It is thereby predicted that the stochastic region becomes thicker with the increase of the beta.

In the high-beta experiments of LHD, the plasma tends to expands from the last closed flux surface (LCFS) determined by the vacuum magnetic field (See, Fig. 1). The pressure / temperature gradient in the external region is finite. The scale length of the pressure profile does not change so much even when the mean free path of electrons exceeds the connection length of the magnetic field line to the wall. There appear MHD instabilities with an amplitude of $10^{-4}$ of the toroidal magnetic field. From the mode number of the activities (m/n = 2/3, 1/2, 2/4), the location of the corresponding rational surface is outside the vacuum LCFS. The location of the mode is consistent with the fluctuation measurement, e.g., soft X-ray detector arrays. For example, m/n = 1/2 modes appear when the averaged beta exceeds 3%. Considering the HINT2 equilibrium field, the rational surface ($\iota = 2.0$) is moved to the region where the connection length to the wall is longer than 100m. That means the appearance of the mode is closely related with the change of the magnetic field topology.

Figure 2 shows that the amplitude of the mode as a function of the pressure gradient. The amplitude decreases with the increase of the magnetic Reynolds number with a similar pressure gradient. The dependence is similar to that of the resistive interchange modes which are observed in the closed region[2)]. Since the edge region of the LHD configuration remains in the magnetic hill with the increase of beta, this characteristic is favorable in realizing the reactor plasmas.

1) T. Evans, et. al., Nature Physics 2 (2006), 419 - 423

2) S. Sakakibara , et al., Plasma Phys. Control. Fusion 50 (2008) 124014

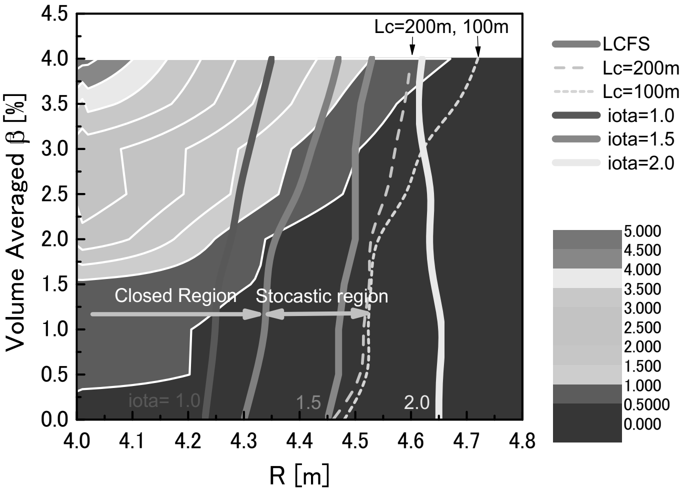


Fig. 1: The radial profile of the plasma beta as a function of the averaged beta is show as a contour map. The location of the rational surface (iota = 1.0, 1.5, 2.0), the location where the connection length to the wall $L_c$ = 100m and 200m, which are estimated by HINT2 code are shown together.

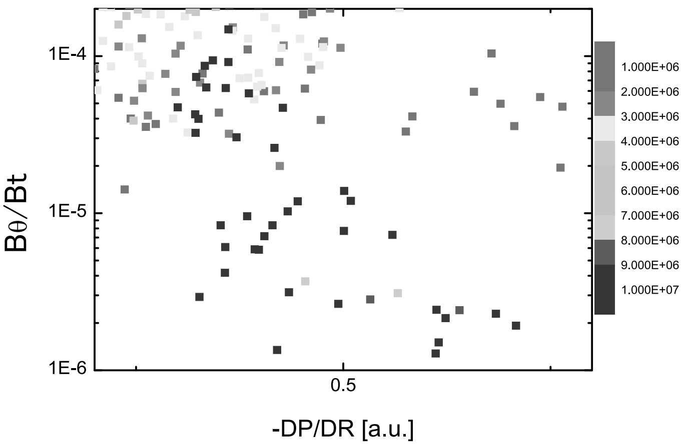


Fig. 2: The amplitude of magnetic fluctuations (m/n = 1/2) as a function of the pressure gradient is shown. The color of the each point indicates the magnetic Reynolds number.