Determination of effective plasma boundary by existence of MHD instabilities excited in the edge stochastic layer of LHD

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In the peripheral region of Heliotron devices e.g. the Large Helical Device (LHD), there is so-called edge magnetic stochastic region, where the connection length to the wall is very short, e.g., several tens / hundreds of meter outside the close magnetic flux surfaces. In the high-beta experiments in the LHD, the plasma tends expands into this region. The pressure/temperature gradient there is finite and MHD instabilities localized in that region appears. Figure 1. shows the location of the rational surfaces and the position where the connection length is equal to 100m and 200m. This estimation is done by the HINT2 equilibrium code. MHD instabilities related with rotational transform iota = 2.0 appears when the plasma beta exceeds 3.0% in the experiments. That is consistent HINT2 expectation that iota = 2.0 surface moves into the region with longer connection length (>100m).

If the appearance of the pressure driven MHD mode is interpreted that related rational surface is in the effective boundary of the plasma, it can be used as the measure to determine the effective boundary of the plasma. Characteristics of MHD mode in the stochastic region and the relation to the boundary will be discussed in detail.

Fig. 1: Location of the outboard LCFS, position where connection length LC=100m, 200m, and the location of the rational surface are estimated as a function of averaged beta by HINT2. Magnetic axis Rax= 3.6m and the aspect ratio Ap = 6.6. MHD mode with mode number of m/n = 1/2, 2/4 is excited in the dotted box region.