§53. Properties of Thermal Decay and Radiative Collapse of NBI Heated Plasma on LHD

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In LHD discharges, the NBI heated plasmas are terminated in two ways: (1) thermal decay(TD) after the termination of NBI and (2) radiative collapse(RC) during the NBI. It is found that the decay and collapse are mainly governed by the plasma density and the heating power. The critical density for the collapse of the RC plasmas is similar to the density-limit scaling laws obtained in other helical devices, i. e., $\bar{n}_e \propto (PB/V)^{0.5}$[1, 2]. In the TD and RC discharges, a significant difference is shown in their total radiation profiles. For the TD plasma, the radiation profile is always inboard -outboard symmetric throughout the discharges. But for the RC case, the total radiation profile develops in several phases. Before the onset of the thermal instability(TI) the profile is rather symmetric, while after that, it evolves from being symmetric towards asymmetric eventually with high radiation located on the inboard side of the torus[see. Fig. 1]. Corresponding variations are shown in the time evolutions of the density and temperature profiles and a substantial contraction of the plasma column is observed immediately after the onset of TI. This spatial and temporal coincidence of the asymmetries in the radiation, density and temperature is similar to that observed with MARFE in tokamaks[3, 4]. But unlike MARFE, the asymmetric radiation(AR) in LHD is rather transient since it appears right before the end of the RC discharge. The underlying cause for the development of the radiation asymmetry was investigated and compared with existing instability models. The result suggests that the high inboard radiation is a manifestation of an enhanced local thermal instability and the AR results from asymmetric developments of TI on inboard-outboard sides during the final stage of the RC discharges. In addition, the possible influence of neutral cooling from edge recycling in further accelerating(but not triggering) the instbatility process was identified with the AR onset usually being followed by a significant increase in the H_α emission.

References

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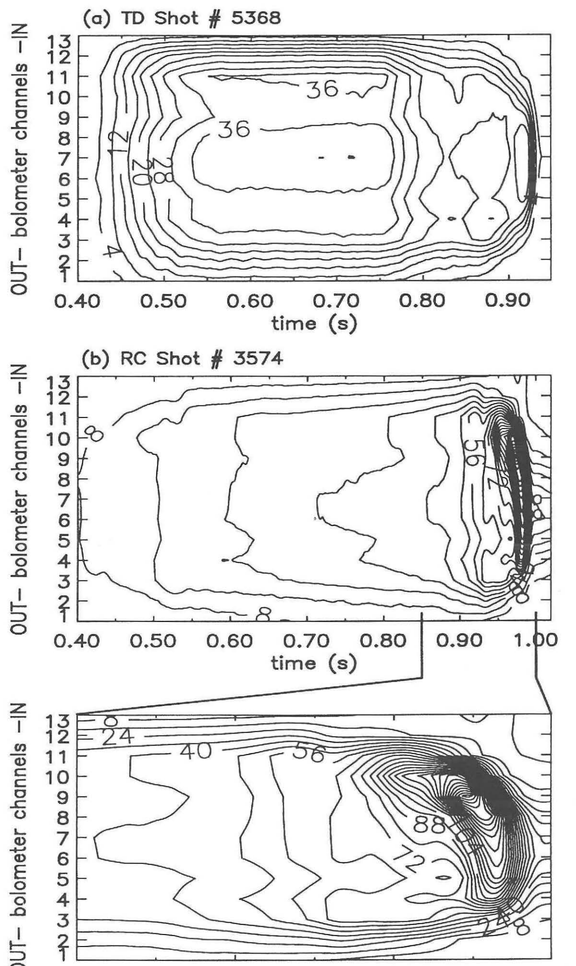

Fig. 1 Contour plots of the time evolution of the chord-integrated radiation brightness for the TD and RC discharges