§18. Progress on H-mode Study

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In this fiscal year we have continued to make efforts to elucidate characteristics of the H-mode induced with the control of the rotational transform ($\iota/2\pi$) profile[1]. With this view, we have studied parameter dependence of the H-mode characteristics, measuring plasma parameters with various plasma diagnostics.

The H-mode experiments are carried out in deuterium and hydrogen plasmas heated with co-injected neutral beams(NBI) up to about 500 kW absorbed power, at toroidal field Bt=1.2 and 1.4 T. A net plasma current Ip is induced up to 50 kA so that $\iota/2\pi$ is increased for the external rotational transform. Line averaged electron density just before the transition is adjusted from 1.5 to 3 x 10^{13} cm^{-3}. As shown in Fig.1, Hα/Dα emission is depressed within 0.2 ms at the transition. At the transition edge electron density measured with thermal Li beam probe (LIBP) is suddenly raised(in 50-100 μs) just inside LCFS and suddenly reduced just outside LCFS, as shown in Fig.1(b). This clearly indicates rapid formation of the edge transport barrier.

There is an obvious threshold current depending on Bt, that is, Ip~30 kA at Bt=1.2 T and ~38 kA at Bt=1.4 T. This suggests the transition closely correlates with the presence of $\iota/2\pi$=1 surface. The threshold (absorbed) heating power is within twice of the ITER scaling law[2]. So far we have not found obvious isotope effect of fueling gas on the transition.

Magnetic fluctuations with various low mode numbers are excited throughout the H-mode discharges. In particular, m/n=1/1 mode excited about 10-20 ms before the transition is often clearly suppressed at the transition, despite $\iota(a)/2\pi$>1. Time evolution of ion saturation current and floating potential across the transition has been measured with fast response Langmuir probes with good spatial resolutions(~1 mm). Floating potential just outside LCFS, which gradually evolves from positive to negative for 10-15 ms before the transition, is suddenly (~100-200 μs) raised at the transition (Fig.2). On the other hand, the potential just inside LCFS is decreased. It is thought that a strong negative radial electric field is generated at the transition near the edge. At the transition Hα/Dα emission often decreases slowly or even increases, because of an integral effect along a line of sight.

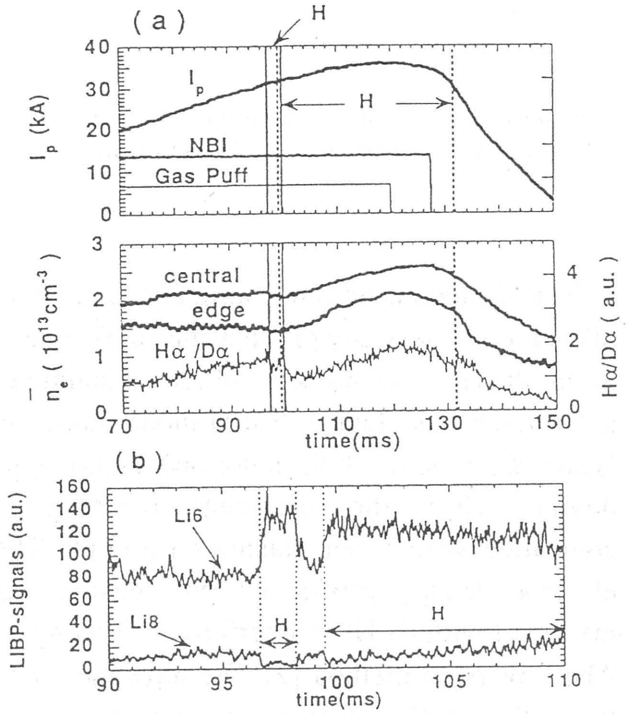

Fig.1 Time evolution of plasma parameters in a typical deuterium H-mode discharge.

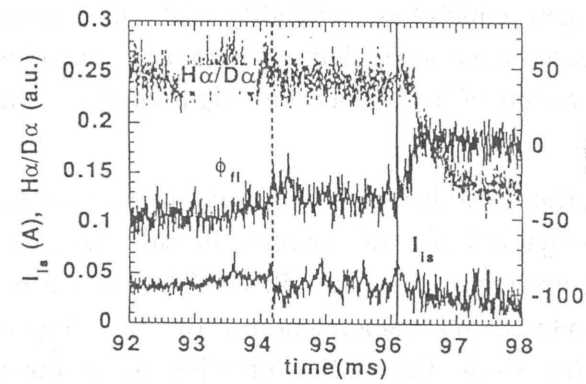

Fig.2 Time evolution of ion saturation current(I_{is}) and floating potential(ϕ_{fl}) measured at ~LCFS together with Ha/Da emission, where a solid vertical line indicates the L-H transition and dotted line the pre transition.

REFERENCES

1) K. Toi et al., in Plasma Phys. Control. Nucl. Fusion Res.(Proc. 15th IAEA conf., Seville, 1994) paper NO. IAEA-CN-60/A6/C-P-3.
2) H-mode database working group, in Plasma Phys. Control. Nucl. Fusion Res.(Proc. 14th IAEA conf, Wurtzburg, 1992) Vol.3, IAEA, Vienna (1993) 251.