§20. Probe Measurement in H-mode

Ohdachi, S., Toi, K., Morisaki, T., Komori, A., CHS Group

The formation mechanism of the transport barrier of the H-mode has been studied extensively since its discovery in ASDEX. It was found that the radial electric field and its shear at the transport barrier become more negative in the H-mode than those in the L-mode. The causality, however, has not been established yet. We report the rapid changes of the profile near the LCFS of CHS during the L-H transition using a Langmuir probe system with good time-space resolution. The probe is inserted from the Upper-Outward port at a horizontally elongated section of the plasma. The insertion angle is 16° to the vertical line and it is nearly perpendicular to a magnetic surface. The probe is moved shot by shot and the profile near the LCFS(-1.0cm ~ +0.5cm) are obtained assuming reproducibility of discharges. We mainly employed one electrode for monitoring the floating potential, \( V_f \), and the other for the ion saturation current, \( I_{sat} \), simultaneously in order to survey the rapid change of profile.

The H-mode in CHS has been obtained with the control of the rotational transform \( \tau \) profile using a small ohmic heating current[1,2]. Time evolution of plasma parameters are shown in Fig.1. One can see the formation of transport barrier from the temporal evolution of \( I_{sat} \) (Fig.1(e) and Fig.1(f)). The formation of the radial electric field up to -50 \( \text{V/cm} \) is also apparent from Fig.1(c) and Fig.1(d). Those are consistent with the former measurement.

However, complex precursor phenomena are observed by probe measurements starting from several milliseconds before the final transition. A gradual decrease of \( V_f \) at the outer position, a gradual increase in \( I_{sat} \) and a reduction of the fluctuation level of \( I_{sat} \) occur simultaneously in the first phase. In the next phase \( V_f \) at the inner position decreases at first while the \( I_{sat} \) profile flattens out gradually. With the sudden drop of the \( H_0/D_0 \) light, the \( I_{sat} \) profile becomes steeper. This steepening indicates the formation of the transport barrier of the H-mode. At the same time \( V_f \) at the inner position becomes more negative and a little later \( V_f \) at the outer position jumps up to a positive value. Though electrostatic fluctuations are also changed, it seems that all of the results can not be explained by the theoretical models of the H-mode using the stabilizing effects of the radial electric field shear. We are now preparing a new Langmuir probe with five electrodes to study the modification of the fluctuation induced-flux during the transition and a magnetic probe array system which can be inserted into the plasma to study magnetic fluctuations.

![Fig.1. Temporal evolution of (a) the plasma current, \( I_p \) and the line averaged electron density, \( n_e \), (b) intensity of the \( H_\alpha/D_\alpha \) light, (c),(d) the floating potential, \( V_f \) and (e),(f) the ion saturation current, \( I_{sat} \). Measurement at two positions (about -10 mm and +0 mm from LCFS) are compared. Graphs (a),(b),(d) and (f) are drawn from a single discharge data. Graphs (c) and (e) are from another discharge. However, the discharge conditions such as \( B_t=1.2\text{T} \) and \( P_{NBI}=750\text{kW} \) are fixed. The timing is synchronized by \( H_\alpha/D_\alpha \) intensity signal at the L-H transition.]

References
2) Toi, K., et. al., Transactions of Fusion Technology 27 190(1995)