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JT-60Uにおける内部輸送障壁形成の加熱パワー依存性

Dependence of the Internal Transport Barrier Formation on Heating Power in JT-60U

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Recently improved confinement due to the formation of internal transport barrier (ITB) has been studied to develop the advanced tokamak operation scenario. The study of ITB is also important to understand what gives rise to the anomalous transport. It is believed that there is a threshold power to form and sustain the ITB. The aims of our ITB formation study in JT-60U are to clarify whether the threshold power exists or not, and also whether the change of diffusivity by the stabilizing effects is sharp or not. These lead to deeper understanding of the physics mechanism of the ITB formation. For this purpose, the dependence of the transport property on heating power has been studied in high β_p mode plasmas.

The experimental conditions consisted of a toroidal magnetic field of 3.7T, a plasma current of 1.3MA, injected neutral beam power (P_{NB}) of 2-15MW, target electron density of ~$1.0\mathrm{x}10^{19}\mathrm{m}^{-3}$ and a positive magnetic shear configuration (q(0)~2). Figure 1 shows the ion thermal diffusivity (χ_i) at the normalized minor radius r/a=0.4, 0.5, 0.6 and 0.86 as a function of P_{NB}. The values of χ_i are evaluated at the steady state condition. As P_{NB} increases from 2 to 4MW, the value of χ_i at each position increases. This indicates the degradation of confinement by the additional heating power. In the range of P_{NB}=4-6MW, χ_i at r/a=0.4, 0.5 decrease with increasing P_{NB}, while χ_i at r/a=0.6 shows essentially no change and χ_i at r/a=0.86 increases. In the range of P_{NB}=6-10MW, however, χ_i at each position decreases with P_{NB} except for the peripheral region. These experimental results show that the change of χ_i in the ITB is gradual by P_{NB} and suggest that the ITB region is expanded by P_{NB} and the local transport is reduced with raising P_{NB}. This may reflect the temporal evolution of ion temperature (T_i) profile without a clear change (see the phase of P_{NB}=8MW in Fig. 2). In high power (15MW) case, on the other hand, the local reduction of the diffusivity was observed at r/a~0.5, and then sudden change of the T_i profile was observed, where the T_i was increased inside of the ITB and decreased outside of the ITB as shown in Fig. 2.

In conclusion, two features of the ITB formation are experimentally confirmed. With the threshold power of around 6MW, the ITB was formed in spite of the absence of an apparent change in the T_i profile. On the other hand, with the threshold power of around 15MW, the ITB was locally formed with a clear transition in the T_i profile from a parabolic type to a box type.

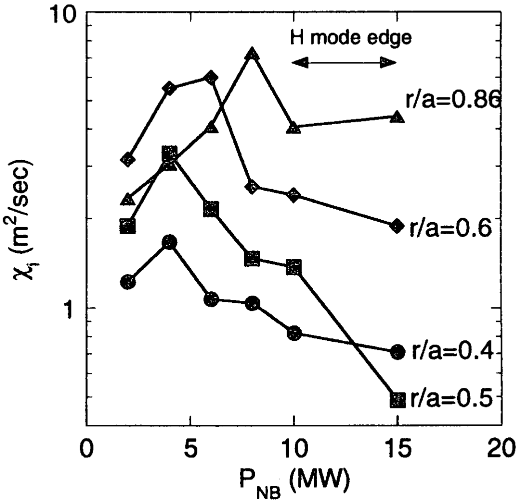

Figure 1. The ion thermal diffusivity (χ_i) at the normalized minor radius r/a=0.4, 0.5, 0.6 and 0.86 as a function of P_{NB} in the positive magnetic shear configuration.

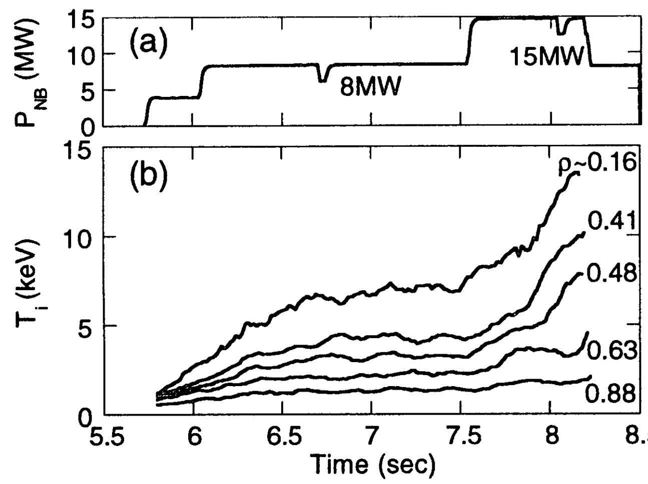

Figure 2. (a) Waveform of P_{NB} and (b) temporal evolution of T_i in each position.