§14. Effects of Magnetic Configuration on Local Transport in High Beta Plasmas

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From the results of the global confinement analysis, the confinement degradation was observed in the high β regime comparing with the empirical scalings, such as ISS95 or ISS04. The local transport analysis in the high β regime was made in ref. [1]. The transport degradation was stronger in the peripheral region. It was found that the β dependence of χ^{eff} was similar to the β dependence of the resistive g-mode transport. In the high β plasmas on LHD, the magnetic flux surfaces are shifted outside due to the Shafranov shift. The main purpose of this study is to distinguish the causes of the gradual confinement degradation with β from following two effects: (1) the change of magnetic configuration by the increment inβ, (2) β value or the gradient of β.

At first, the change of the magnetic flux surface structure by the increment in β and its effect on the global confinement characteristics are investigated. The NBI heated plasmas with $A_p = 5.8$ are analyzed in this study. The scaling of ISS04 and the renormalization factor, f_{ren}, which represents the device or magnetic configuration effects on global τ_E, are described in ref. [2]. For the high β plasmas, f_{ren} is interpolated assuming that f_{ren} is expressed as a function of the geometric center position of the $\rho = 2/3$ magnetic surface, $R_{geo}(2/3)$. When the interpolated f_{ren} is used in the comparison with the ISS04 scaling, the degradation with increment in β becomes unclear. It seems that the global confinement degradation with $\langle\beta\rangle$ may be explained by the change of the magnetic configuration, if $R_{geo}(2/3)$ represents the magnetic configuration.

In order to evaluate the dependence of local transport coefficients on the magnetic configuration, the renormalization factor for the transport coefficients, $g_{ren\chi}$ is introduced. The modelded transport coefficients χ^{ISS04}, which has the same non-dimensional parameter dependence as τ_E^{ISS04}, is introduced as the reference in this analysis. The value of χ^{ISS04} is determined to make $\chi^{eff}/\chi^{ISS04} = 1$ for the $R_{ax}^{vac} = 3.6\,\mathrm{m}$ plasmas in the region of $\beta < 1\%$, where χ^{eff} is the experimentally derived transport coefficients. $g_{ren\chi}$ is the average of χ^{eff}/χ^{ISS04} in the low β regime. As the geometric center of the magnetic flux surface is shifted torus outward, $g_{ren\chi}$ increases at any minor radial positions. This tendency seems to be the same as in the global confinement property.

In figure 1, the dependences of χ^{eff}/χ^{ISS04} on the geometric center of the magnetic flux surfaces, $R_{geo}(\rho)$, are shown. They are compared with the configuration effects which are derived in the low β regime with various magnetic axis positions (△ and ◯). Fig. 1 (a) is for $\rho = 0.5$ and (b) is for $\rho = 0.9$. The degradation of the local transport with the increment in $\langle\beta\rangle$ seems to be comparable with or slightly smaller than the degradation by the torus outward shift of the magnetic flux surface at $\rho = 0.5$. On the other hand, at the peripheral region of $\rho = 0.9$, it is found that some effects other than the change of the magnetic flux surface may exist. Although the the degradation with $\langle\beta\rangle$ seems to be explained by the change of the magnetic configuration from the global confinement analysis, transport degradation by some effects which are directly causaed by β or $\nabla\beta$ may exist in the peripheral region from the results of the local transport analysis.

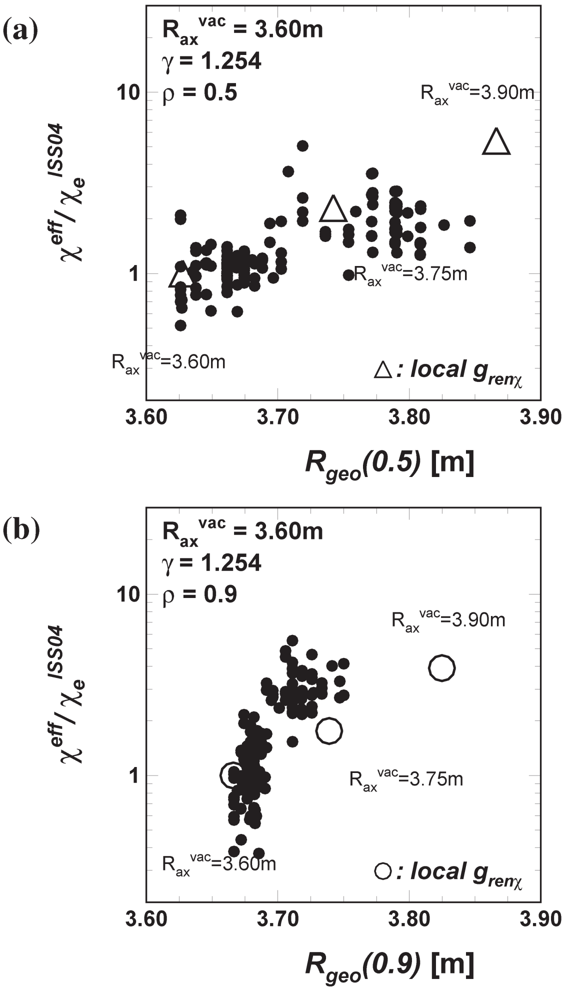

Fig. 1. Dependences of χ^{eff}/χ^{ISS04} on $R_{geo}(\rho)$. △ and ◯ represent the configuration effects which are derived in the low β regime. (a) $\rho = 0.5$, (b) $\rho = 0.9$.

References

1) H. Funaba, *et al.*, Fusion Sci. Tech., **51** 129 (2007).
2) H. Yamada, *et al.*, Nucl. Fusion **45** 1684 (2005).