§12. Comparative Study for the Estimate of Effective Helicity in LHD – in Relation to Develop the Analysis of the Electron Root Physics in Helical Systems –

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The non-axisymmetry of the magnetic field configuration has been the key factor to determine the parameter regime for the transition from ion root to electron root in helical plasmas. This feature is attributed to the fact that ripple diffusion in low collisional regime can be controlled through the non-axisymmetry of the magnetic field. In the LHD experiments, the transition to electron root has been clarified in to be crucial to the reduction of the ion thermal diffusivity, the establishment of electron internal transport barrier (eITB) formation and the prevention of the impurity accumulation at low collisional regime etc. Thus, the precise estimate of the non-axisymmetry of the magnetic configuration, that is, so called "effective helicity, ε_{eff}", is of vital importance to establish common knowledge to grasp how ε_{eff} depends on magnetic configuration variation in LHD to progress study to clarify the configuration dependence of such as above mentioned feature.

The ε_{eff} is calculated by evaluation of ripple diffusion with numerical codes, such as NEO [1], DCOM [2] and GIOTA [3], and compared each other by taking several configurations with different magnetic axis position, Rax, in LHD as examples. The NEO and GIOTA codes are based on the field-line-integration scheme for particles trapped in a local ripple to estimate ripple diffusion. The DCOM code is based on Monte-Carlo approach. As shown in Fig. 1, these numerical codes reproduce the same tendency that ε_{eff} becomes minimum for the case of R_{ax}=3.53m. Furthermore, the value of ε_{eff} itself is in the range of the factor of 2 among these codes. Based on this comparative (benchmarking) study, the

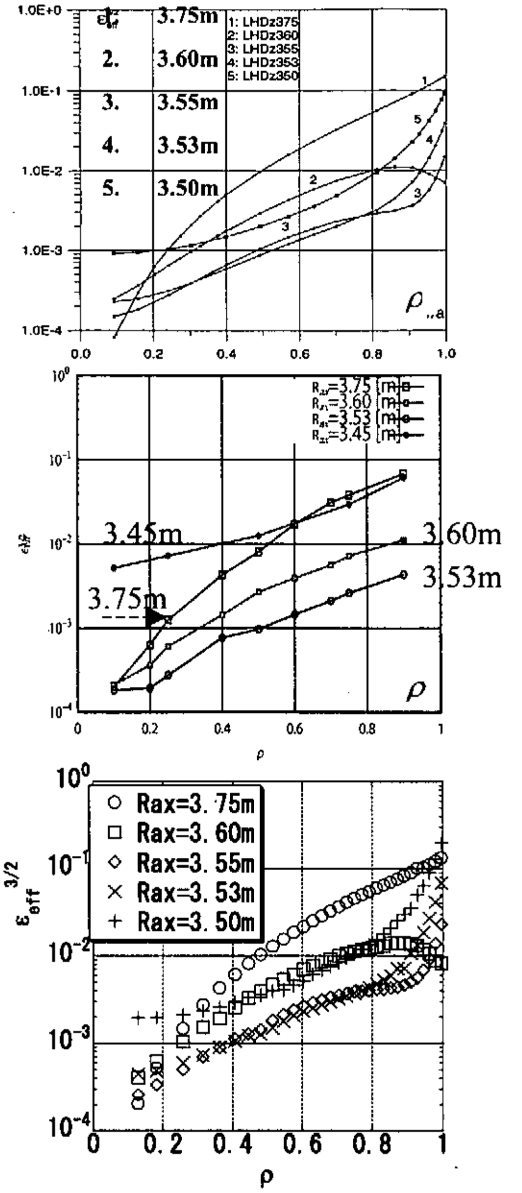

Fig.1 Comparison of effective helicity ($\varepsilon_{eff}^{3/2}$) evaluated with (a) NEO, (b) DCOM and (c) GIOTA codes for LHD configurations with different R_{ax}.

similarity/differences (numerical scheme, the degree of accuracy, required computational time etc.) between these codes are well clarified, which is rather useful to consider the appropriate application of these codes for experimental/analysis situations.

References

1)Nemov, V. V. et al., Phys. Plasmas 6, (1999) 4622.
2)Murakami, S., et al., Nuclear Fusion 42, (2002) L19-L22.
3)N.Nakajima, M.Okamoto and T.Amano, NIFS LHD Technical Report 1, p.288 (in Japanese).