§5. Neoclassical Transport Optimization of LHD

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The existence of the 1/ν regime, in which the neoclassical transport coefficients are inversely proportional to the collision frequency, increases the neoclassical particle and heat transport in non-axisymmetric devices to levels far above those of axisymmetric tokamaks in the fusion-relevant long-mean-free-path (*lmfp*) regime. Thus, the reduction of neoclassical transport is one of the key issues for any future fusion reactor based on a non-axisymmetric configuration.

In this paper we study the neoclassical transport in strongly inward-shifted configurations of the LHD and find a neoclassical-transport-optimized configuration by evaluating a mono-energetic neoclassical transport coefficient. In order to compare the neoclassical transport properties of this optimized configuration with those of ``advanced stellarators'', an effective helical ripple, ε_{eff}, is also evaluated from the transport coefficients obtained. The neoclassical transport coefficient in the 1/ν regime is proportional to ε_{eff} and the neoclassical transport in the *lmfp* regime can be easily estimated by the value of ε_{eff}.
We evaluate a mono-energetic local transport coefficient using DCOM (Diffusion COefficient calculator by Monte-carlo method)[2] in which test particle orbits are followed solving the equations of motion in Boozer coordinates and the transport coefficient is evaluated statistically from the mean square displacement of the particles.

Figure 1 shows the mono-energetic transport coefficient evaluated by DCOM code normalized by the plateau value of the equivalent circular tokamak, $D_p=(\pi/16)(v^3/\iota R\omega_c^3)$, where v, R, ι, and ω_c are the velocity, the major radius, the rotational transform, and the cyclotron frequency, respectively. With respect to 1/ν transport, the optimum configuration is found when the magnetic axis has a major radius of 3.53m. In this case, the effective helical ripple is very small, remaining below 2% inside 4/5 of the plasma radius (Fig. 2). This indicates that a strong inward shift of the magnetic axis can optimized the neoclassical transport of the LHD configuration to a level typical of so-called``advanced stella-rators''.

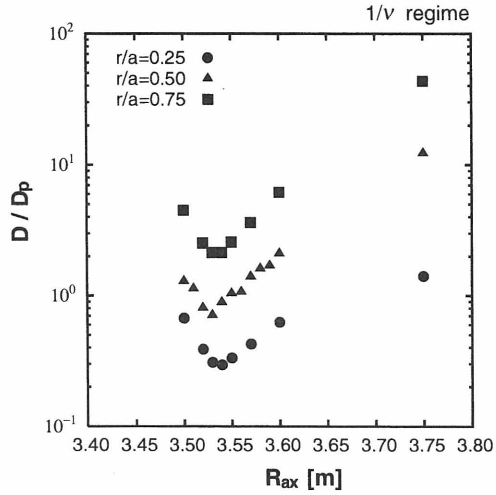

Fig. 1 Normalized neoclassical transport coefficients evaluated by DCOM as a function of the magnetic axis position in the 1/ ν regime.

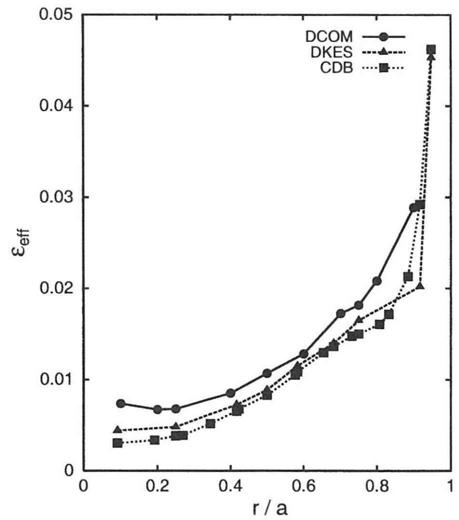

Fig. 2 Radial profiles of the effective helical ripple in the R_{ax}=3.53m configuration evaluated by DCOM, DKES and an analytic formula.

REFERENCES

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[2] A. Wakasa, et al., J. Plasma Fusion Res. SERIES, Vol. **4** (2001) 408-412.