§18. Ion Neoclassical Transport in the Presence of Steep Density Gradient

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A δf simulation code named "FORTEC" (Finite ORbit Transport study by the Extensive Code) has been developed based on the new method employing two weights assigned to each simulation particle [1]. By using "FORTEC", the modifications to ion neoclassical transport from the finite orbit width dynamics are investigated. The simulations which are performed over global poloidal cross section enable us to calculate the neoclassical transport in both the region near magnetic axis and that far from it (including the edge region of confined plasma). Moreover, the global simulations enable us to calculate nonlocal transport fluxes which depend not only on the local gradients but on the entire density and temperature profiles as well. Our calculations focus on the banana-plateau regime in which the present fusion plasmas are most operated.

Figure 1 shows the dependence of ion thermal conductivity on density gradient length. When the banana width increases,the ion thermal conductivity is significantly reduced from its conventional neoclassical result.

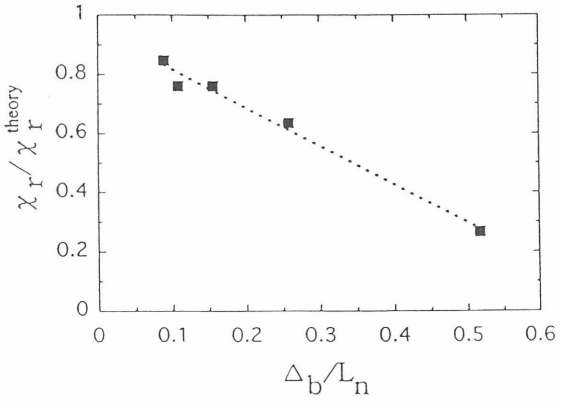

Fig.1. Ion thermal diffusivity χ_r vs. Δ_b (banana width) / L_n (density gradient scale length).

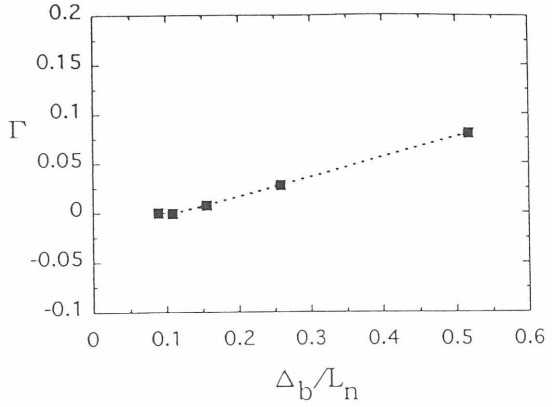

Fig.2. Ion particle flux Γ vs. Δ_b (banana width) / L_n (density gradient scale length).

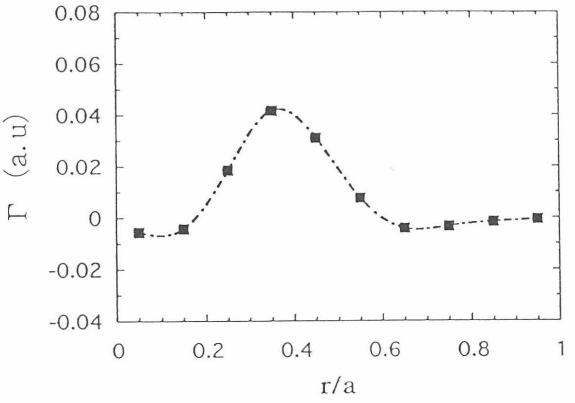

Fig.3. Distribution of ion particle flux Γ.

It is found from Fig.2 and 3 that in the presence of steep density gradient ion particle flux can be driven by ion-ion collisions alone. The simulation results suggest that the reduction of the conductivity and the particle flux depend linearly on $(1/n)dn/dr$. Since the finite orbit effect on electrons is very weak, the electron transport is unchanged in the presence of steep density gradient. Then the neoclassical particle transport could generate a radial electric field, which is under investigation.

References

[1] Wang, W., Nakajima, N., Okamoto, M., Murakami, S., Plasma Phys. Contr. Fusion **41**, (1999) 1091