Electrostatic potential calculations for whole-volume gyrokinetic modeling of Stellarators

Toseo MORITAKA[1,2], Michael COLE[3], Robert HAGER[3], Seung-Hoe KU[3], Choong-Seock CHANG[3] and Seiji ISHIGURO[1,2]

[1] *The Graduate University for Advanced Studies, SOKENDAI, Toki, Gifu 509-5292, Japan.*

[2] *National Institute for Fusion Science, Toki, Gifu 509-5292, Japan.*

[3] *Princeton Plasma Physics Laboratory, Princeton, NJ 08543-0451, USA.*

The gyrokinetic model has been widely employed for kinetic plasma simulations on turbulent and neoclassical transport phenomena in magnetic confinement devices. Flux coordinates are suitable to take field line structures into account in gyrokinetic simulations inside the last closed flux surface. On the other hand, X-point Gyrokinetic Code (XGC)[1] developed for whole-volume modeling of Tokamaks utilizes finite element method and unstructured mesh to estimate electrostatic (or vector) potentials. The unstructured mesh generated according to the flux function covers the entire region inside the vacuum vessel. We are recently extending XGC for Stellarators with non-axisymmetric geometries and stochastic field line structures[2]. So far, we have demonstrated ion temperature gradient mode in the core region[3] and high-energy particle motion in the entire region[2]. Estimation of electrostatic potential in arbitrary field-line structures, including flux (or field-line) average and fluctuation components, remains for implementation toward the whole-volume modeling. A large number of iterations are needed to solve the gyrokinetic Poisson equation for non-axisymmetric geometries. We solve the equation for each averaged component of unit charge density before the time integration process. Using the stored solutions, we can obtain average and fluctuation components of electrostatic potential within a few iterations in each time step. We will present examples of the electrostatic potential calculation in the stochastic region of Large Helical Device by using unstructured meshes generated by considering three-dimensional field line structures.

References

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