27D35P

有限ベータLHDプラズマにおける周辺磁場構造の数値的研究
Numerical study on the peripheral magnetic field structure in LHD finite beta plasmas

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Plasma confinement by magnetic field is very important in put the nuclear fusion into practice. But it is known that the peripheral magnetic field structure falls into disorder and a confinement efficiency of plasma falls when a beta value(the ratio of plasma pressure to magnetic field pressure) goes up. A goal of this study is to examine a new index which shows a feature of the peripheral magnetic field structure.

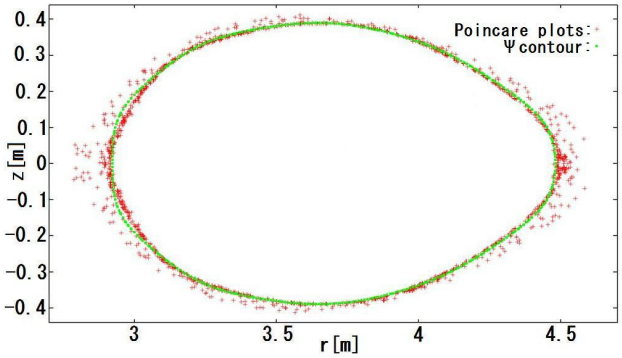
A popular research of magnetic field structure is to consider a feature of magnetic field structure based on an original clear magnetic surface in case of inputting a perturbation of magnetic field to the magnetic field configuration where the clear magnetic surface exists. However, when a disarrayed magnetic field structure exists in the asymmetric magnetic field configuration like helical plasmas, a structure of false magnetic surface is the serious problem because the original clear magnetic surface doesn't exist.

In this subject, we smooth lines of magnetic force in the disarrayed magnetic field region by using the RBF(Radial Basic Function) expansion and define the false magnetic surface. Concretely, we assign "magnetic surface quantity" to the coordinates of Poincare plots, (r,z) decided by the line of magnetic force which passes the major radius place on equatorial plane $r_{start}[(r,z)=r_{start},0]$. Then we calculate the weight coefficients, w_i by least square fitting with satisfying the relation; the right side of (1) equals r_{start} and define the false magnetic surface quantity Ψ as follows.

$$\Psi(r,z)=\sum_{i=1}^{100} w_i f_i(r,z;r_i,z_i),\quad f_i(r,z;r_i,z_i)=\exp\left\{-\left((r-r_i)^2+(z-z_i)^2\right)/\sigma^2\right\} \qquad (1)$$

In this research, we made high beta plasmas in LHD the analysis target and used calculation results of HINT2 cod for the Poincare maps. Fig.1 shows a Poincare plot of magnetic flux line which passes the disarrayed region and a false magnetic surface obtained from RBF expansion when the beta value equals about 6%.

Fig.2 shows a distribution of the false magnetic surface quantity Ψ which is given at Fig.1. Variance of false magnetic surface quantity in the outside/inside of minor radius direction and all parts could be a strong index to the degree of disorder in magnetic surface structures.



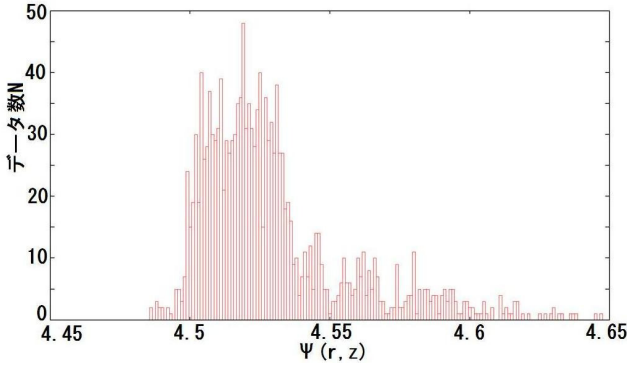


Fig.1 poincare plots and Ψ contour at $\beta=6.02\%, r_{start}, \Psi=4.52$ Fig.2 Ψ distribution at $\beta=6.02\%, r_{start}=4.52$

Reference

[1] M.Itagaki et al.; Plasma Phys. Controll. Fusion 54 (2012)