

§2. Construction of Generalized Magnetic Coordinates for Magnetic Field Containing Magnetic Islands

Kurata, M. (Dept. of Energy Engineering and Science, Graduate School of Engineering, Nagoya Univ.), Todoroki, J.

The Generalized Magnetic Coordinates (GMC) are curvilinear coordinates (ξ, η, ζ) , in which the magnetic field is expressed as

$$\mathbf{B} = \nabla\Psi(\xi, \eta, \zeta) \times \nabla\zeta + H^\zeta(\xi, \eta)\nabla\xi \times \nabla\eta,$$

where $H^\zeta = \sqrt{g}B^\zeta$ does not depend on ζ , and \sqrt{g} is Jacobian. When the good magnetic surface exists, Ψ becomes independent of ζ and $\Psi(\xi, \eta) = \text{Const.}$ expresses the magnetic surface. When Ψ depends on ζ , $\bar{\Psi}(\xi, \eta)$ is the averaged magnetic surface which is obtained by averaging Ψ with respect to ζ . The breaking of magnetic surfaces like magnetic islands is investigated by using ζ -dependent part $\tilde{\Psi} = \Psi - \bar{\Psi}$. The GMC are to be constructed so that Ψ depends on ζ as little as possible.

The GMC was constructed by using Fourier expansion in three dimensions to the ABC magnetic field in the Cartesian coordinates that can express topological toroidal magnetic field.^{1,2)} In order to treat an aperiodic field, the coordinates are constructed to the same model field in Fourier series in the toroidal direction and the cubic B-spline function in other two dimensions.³⁾

Here the coordinates are applied to the magnetic field containing magnetic islands. By using Fourier mode components of perturbation $\tilde{\Psi}$ of magnetic field resonating rotational transform of the rational surfaces, the residue of tangent map and width of magnetic islands are evaluated in the GMC, and compared with those of field line tracing.

The residues of magnetic islands of rotational transform $\iota = 1/5, 1/7$ evaluated in the GMC and those obtained by field line tracing are shown in Fig.1. The two values are in good agreement on both O point and X point.

The magnetic island separatrix of $\iota = 1/7$ are shown in Fig.2 by using averaged magnetic surface $\bar{\Psi}$ as a measure of

vertical axis. The horizontal dot line in the center shows rational surface. The solid line shows magnetic island separatrix evaluated from perturbation $\tilde{\Psi}$ and the dot line shows that of Poincaré map of field line tracing. The two curves are in good agreement.

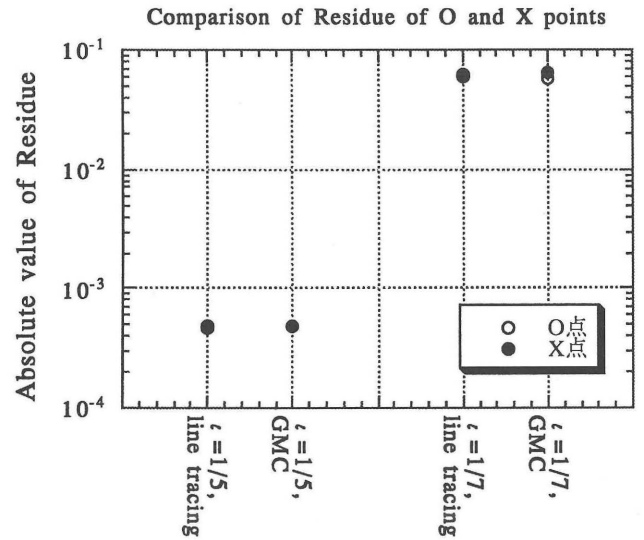


Fig.1. Comparison of Residue of O and X Points.

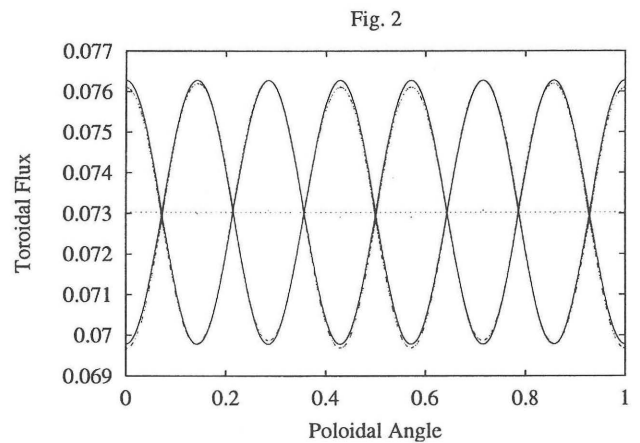


Fig.2. Comparison of Magnetic Island separatrix in the GMC (Solid Line: GMC, Dot Line: Line Tracing).

Reference

- 1) Kurata, M. and Todoroki, J. : J. Plasma Fusion Res. SERIES, Vol. 1 (1998) 491-494.
- 2) Kurata, M. and Todoroki, J. : NIFS-PROC-40 (1999) 9-18.
- 3) Kurata, M. and Todoroki, J. : NIFS-PROC-46 (2000) 11-20.