§2. Three-Dimensional MHD Stability Analysis with the CAS3D Code

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Recently, three-dimensional ideal MHD stability code which is called CAS3D was developed by Schwab[1)] for the MHD stability analysis of the helias configurations. We introduced one version of this code to NIFS to apply it to the heliotron/torsatron plasmas. In this version, the incompressibility of the plasma is assumed, which is utilized to eliminate one component of the displacement vector ξ . The CAS3D code solves an eigenvalue problem based on the energy principle of the ideal MHD equations

$$\lambda W_K = W_P, \quad (1)$$

and gives an eigenvalue λ as the growth rate of the normal mode, where W_K and W_P are the perturbed kinetic and potential energies, respectively. The Boozer coordinates are used for the expression of these energies. The three-dimensional equilibrium which is examined can be provided by the VMEC code[2)]. Fourier representation is employed in the poloidal and the toroidal directions and the convolutions between the equilibrium and the perturbed mode numbers are calculated automatically. It is noticed that there is a rule in the coupling of the toroidal modes, due to the periodicity of the equilibrium quantity. In the case that the pitch number of the equilibrium is N_P, the toroidal mode coupling occurs only in the group in which arbitrary two modes specified by the toroidal mode numbers n_1 and n_2 satisfy the relation,

$$n_1 \pm n_2 = \ell N_P \quad (2)$$

with an integer ℓ. The groups are called mode families. In the radial direction, the hybrid finite element method is used, which must shows the convergence of square of the grid number.

Fig.1 shows an unstable eigenfunction corresponding to the radial component of the displacement vector in the equilibrium of a heliotron/torsatron plasma with 10 field periods. This structure indicates that the interchange mode may be the most unstable. Fig.2 shows the convergence property of the eigenvalue of this mode in the radial direction. We can see an excellent property of the convergence.

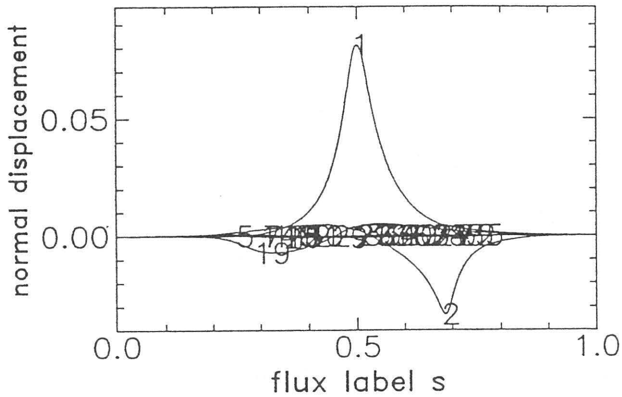

Fig.1 An unstable eigenfunction in a torsatron/heliotron plasma.

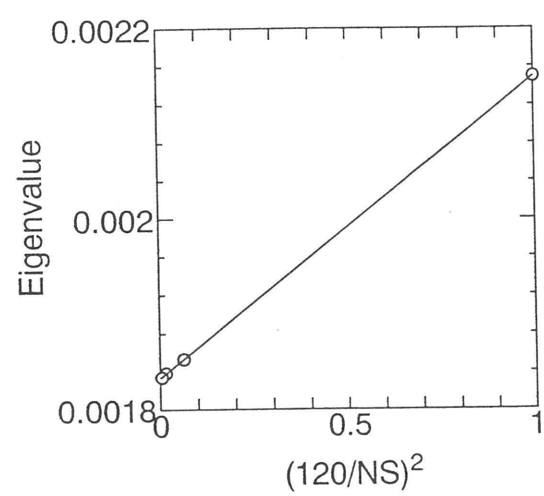

Fig.2 Convergence property for the radial grid number.

References
1) Schwab C., : Phys.Fluids B5 (1993) 3195.
2) Hirshman S.P., et al. : Comp.Phys.Comm. 43 (1986) 143.