§31. Magnetic Configuration of Quasi-axisymmetric Stellarator

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Conceptual design of a new stellarator has been done for the post-CHS satellite machine. The new concept of a quasi-axisymmetric stellarator was adopted. This configuration is an reciprocal concept to the quasi-helical symmetry in terms of the magnetic field ripple structure. Figure 1 shows the radial profiles of largest ripple components as well as magnetic well [(0,0)] and the fundamental toroidicity [(-1,0)] where (m,n) stands for the poloidal and toroidal mode numbers. The mode (2,1) corresponds to the helical ripple for the $\ell = 2$ system. Amplitudes of non-axisymmetric components ($n \neq 0$) are suppressed below 2 %.

Such configuration can be created for the low-aspect-ratio system ($A_p = 4.2$) with the number of toroidal periods N = 2. The profile of rotational transform is almost flat and slightly increasing to the edge value of 0.28. The configuration is defined by the shape of the outermost magnetic surface and the modular coil system is necessary to realize it. Figure 2 shows the nine cross sections in one toroidal period.

Because the dominant magnetic field spectrum is the one due to the toroidicity, the structure of the magnetic field strength is similar to tokamak. The contour lines of the field strength in the toroidal cross section are almost vertically straight for all cross sections. Figure 3 shows the contour lines on the magnetic surface (poloidal and toroidal angle plane) for the half radius (r/a = 0.5).

The characteristics of quasi-axisymmetry is kept for the finite beta equilibrium with the fixed boundary calculation for $\beta = 2$ %. The free boundary calculation gives the outward shift of plasma and the deformation of the boundary shape. However, if the position of the plasma is pushed back by the vertical field, the original axisymmetry is recovered.

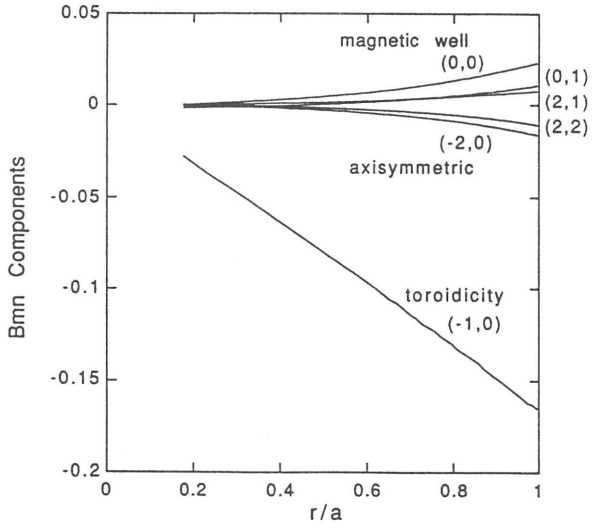

Fig. 1 Profiles of dominant ripple spectrum

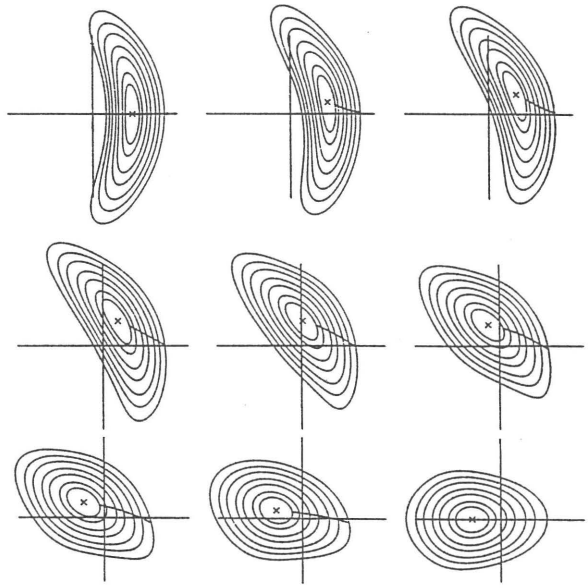

Fig. 2 Toroidal cross sections of boundary

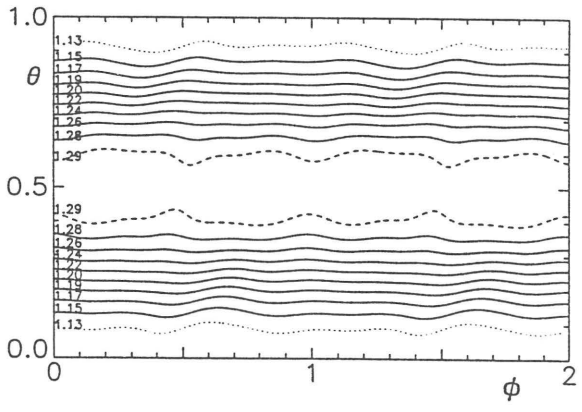

Fig. 3 Mod-B contour on magnetic surface