§15. Quasi-Axisymmetric Configuration with the Toroidal Period Number of N=3

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Quasi-axisymmetric(QA) helical configurations are being studied as post-CHS. The QA configuration with the toroidal period number of N=2 and the aspect ratio of A_p=4.2 was already obtained and it's characteristics have been studied in detail[1]. In the further configuration optimization study toward the final specifications, the study of other alternative configurations with different toroidal periods and also different aspect ratios is an important theme.

The QA configuration with the toroidal period number of N=3 was obtained with the Nuehrenberg's optimization method[2]. In the present optimization code, the outermost flux surface shape is expressed using 43 Fourier coefficients R_{mn}, Z_{mn} for the poloidal mode numbers of $|m| \leqq 4$ and the toroidal mode number of $|n| \leqq 4$. The penalty, which should be minimized in the 43 dimensional space by a iteration, of the obtained configuration is the summation of that for the non-axisymmetric Fourier components (B_{mn}) of the magnetic field strength in Boozer coordinates, rotational transform($\iota/2\pi$) and ballooning stability. The initial value of the Fourier coefficients expressing the outermost flux surface shape was taken from a new QA configuration with N=2, A_p=3.9 and $\iota/2\pi \sim 0.35$[3]. At the first step, the aspect ratio and the rotational transform were specified to be A_p=5.4 and $0.5< \iota/2\pi <0.6$ to avoid the large change of flux surface shape per a toroidal period. The optimization was done with the assumption that the volume averaged β is $<\beta>$=2.5-3.6% and the net toroidal current is zero. Figure 1 shows the Fourier components of the magnetic field strength of the obtained configuration in the cases of $<\beta>$=0% and $<\beta>$=3.6%. The non-axisymmetric components are suppressed to be less than 3% in this β range. The degradation of the quasi-axisymmetry depending on β is small because of the small Shafranov shift, similar to that in the new N=2 configurations[3]. The Mercier criterion is unstable and the magnetic well (m,n)=(0,0) in the vacuum condition is small compared with the low aspect ratio N=2 configurations. The evaluation of the Mercier criterion in the optimizing iteration is a future theme. However, the well is formed in the finite β condition and the ballooning stability is attained in the β range of $<\beta>$ < 3.8%. The optimization of the N=3 configurations with lower aspect ratios is being done now.

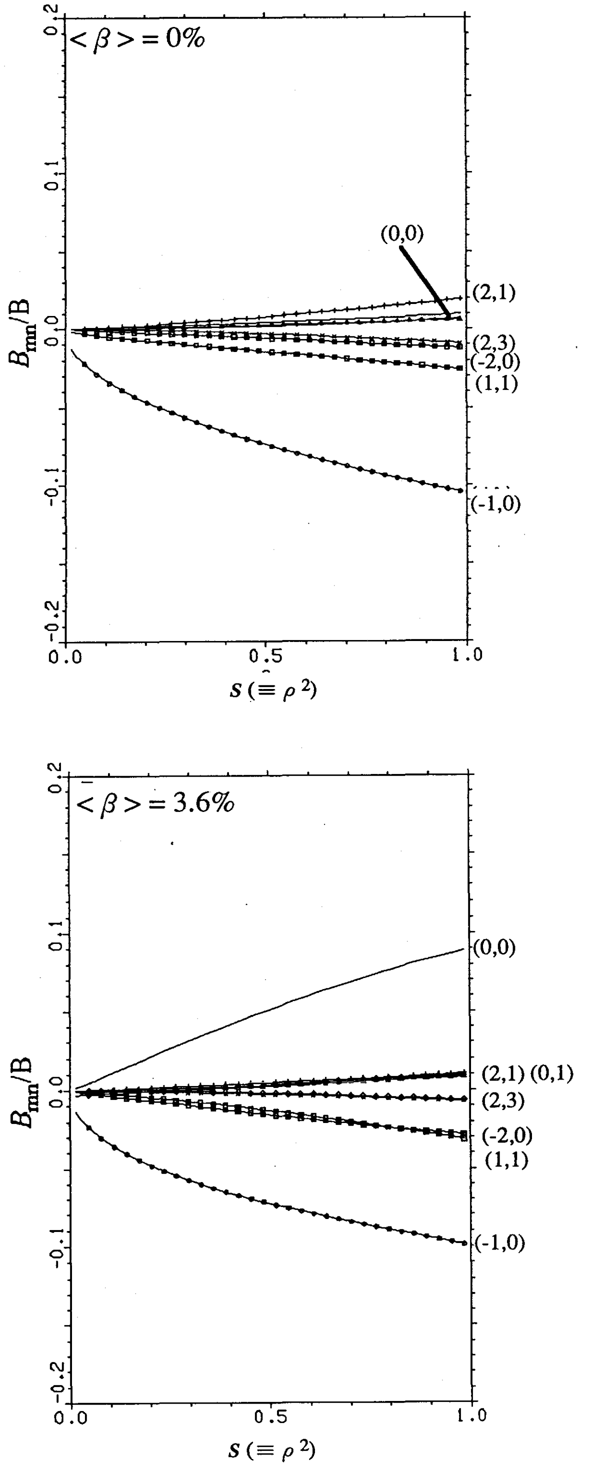

Fig.1 Fourier Components of the Magnetic Field Strength

Reference

1) Okamura,S. et al., Journal of Plasma and Fusion Research SERIES 1(1997)p.164

2) Nuehrenberg,J., Zille,R., Phys.Lett.A.129(1988)113

3) Okamura,S. et al., in this issue