# §22. Dependence of Magnetic Well on the Aspect Ratio for Stellarators and Tokamaks

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In the discussion of MHD stability of toroidal configuration, it is generally said that the toroidicity gives the magnetic well which means the low aspect ratio configuration is more favorable for the MHD stability. This general characteristic is confirmed by the demonstration of stability of very high beta plasmas in the spherical torus experiments. In this report, in order to find the relation between the magnetic well and the aspect ratio, equilibria are calculated using VMEC code in the fixed boundary condition for the series of quasi-axisymmetric stellarators and axisymmetric tokamaks with different aspect ratios. For the first step of analysis, zero plasma pressure is assumed.

To start with stellarators, we take Fourier modes of boundary shape of 2b32 configuration of CHS-qa design. In the Fourier mode description, the aspect ratio can be varied by changing $R_{00}$, which is a Fourier mode for the radial coordinate with both toroidal and poloidal mode numbers vanishing. In such an analysis, if the number of toroidal period is kept constant (N=2 for CHS-qa), the geometrical twisting rate changes as the aspect ratio is varied. Figure 1 shows the magnetic well depth as a function of the aspect ratio with the rotational transform at the magnetic axis and the edge. The reason for the small magnetic well for the very low aspect ratio design might be that a large twisting structure of the boundary shape diminishes the magnetic well created by the strong toroidicity.

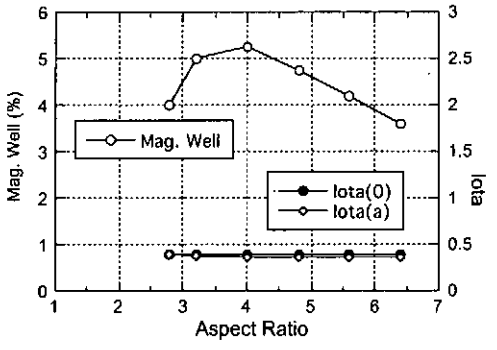


Fig. 1 Magnetic well and rotational transforms for N=2 quasi-axisymmetric stellarator configurations

In the standard stellarator design, the toroidal period number is selected in proportion to the aspect ratio. Figure 2 shows the variation of the magnetic well for the quasi-axisymmetric stellarator with different number of N. In another description, the aspect ratio per period is kept constant. The strong magnetic well is created for the low aspect ratio configuration which we expect to observe.

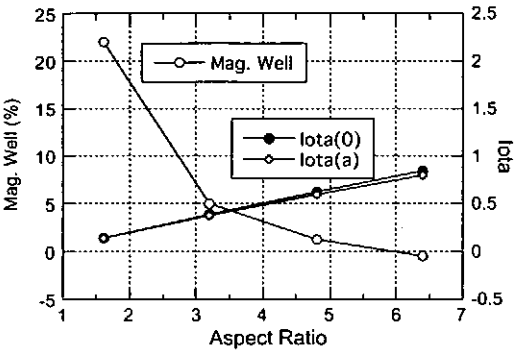


Fig. 2 Magnetic well and rotational transforms of stellarators with fixed aspect ratio per period

Axisymmetric tokamak configuration is obtained by taking only the axisymmetric Fourier modes (m=0 terms) from the 2b32 CHS-qa configuration. Figure 3 shows the magnetic well dependence on the aspect ratio keeping the edge rotational transform constant (varying the plasma current).

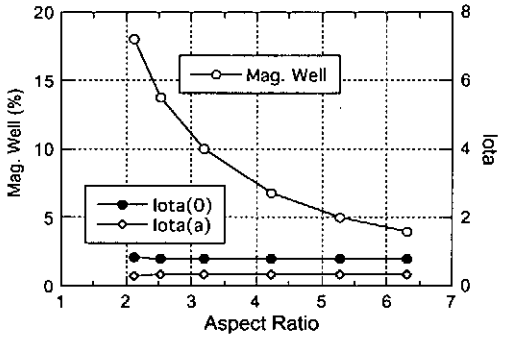


Fig. 3 Magnetic well and rotational transforms of tokamaks with edge rotational transform constant

When the plasma current is kept constant (with increasing rotational transform for higher aspect ratio), the dependence is still similar to the constant q case as shown in Fig. 4.

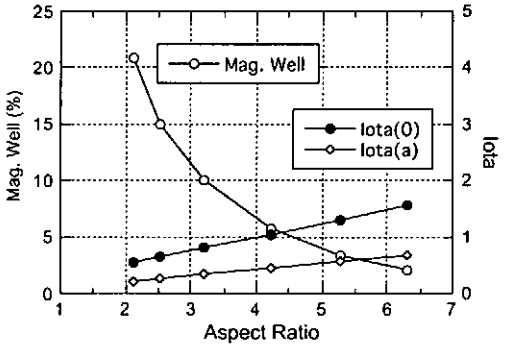


Fig. 4 Magnetic well and rotational transforms of tokamaks with constant plasma current