§18. The Control of CHS-qa Magnetic Configuration

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The CHS-qa was designed to have a good quasi-axisymmetric magnetic characteristic with modular coils, which are suitable to produce any advanced magnetic configurations. However for an experimental device modular coils are not flexible because they realize only one designed magnetic configuration. In order that an actual experimental device can provide us with the sufficient flexibility of the magnetic configuration, other coils are needed to be arranged. In CHS-qa, the 3-pair poloidal coils and the additional toroidal coils outside of modular coils are planned to be installed. The poloidal coils allow to control the position of the magnetic axis and can also be used for Ohmic heating. The additional toroidal coils make the control of the rotational transform possible. Here, assuming that the magnetic field made by those coils is homogeneous, we investigate the flexibility of the CHS-qa system in the actual operation.

Outside of the last closed magnetic surface (LCMS) of the present CHS-qa, 4 large islands, which correspond to the surface on which iota = 2/5, exist. These islands are very sensitive to a vertical field, so even if the small vertical field is added to the CHS-qa standard magnetic configuration with poloidal coils, the reaction of the configuration is large. In Fig.1 the vertically elongated cross sections are shown which are the cases that the vertical homogeneous magnetic field, which corresponds to ± 1% of the toroidal magnetic field made by modular coils in strength, is added. In these cases, the quasi-axisymmetric property is not so broken, and the helical components are reduced when the magnetic axis is shifted inwards.

Additional toroidal coils are suitable to provide with the flexibility of the rotational transform, but the break of quasi-axisymmetric property by these coils is a strong concern. However it is revealed that the toroidal coils may not have the effect deteriorating the quasi-axisymmetric property. In Fig.2 the Fourier components of magnetic field in Boozer coordinates in case that the toroidal field, which is proportional to $1/R$ and corresponds to +15% of modular coil's field, is added. The Fourier components are almost the same as that of the standard configuration. Actual toroidal coils have bumpy ripples, so these effect should be taken into account. The appropriate design of toroidal coils has been investigated.

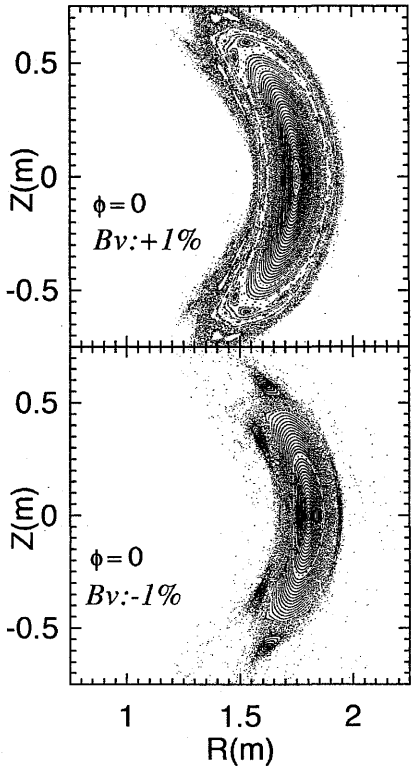

Fig.1 The vertically elongated cross section when ±1% of the homogeneous vertical field is added.

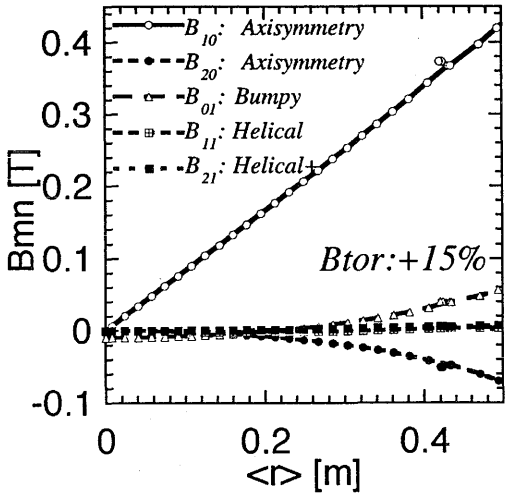

Fig.2 The Fourier components of field in Boozer coordinates when 15% of toroidal field is added.