§26. Maximum-*J* Capability in a Quasi-Axisymmetric Stellarator

Yokoyama, M., Itoh, K., Okamura, S., Matsuoka, K., Itoh, S.-I. (Kyushu Univ.)

The maximum-J (J is the second adiabatic invariant) capability has been investigated in a quasi-axisymmetric (QA) stellarator configuration[1,2] to explore possibility of suppression of turbulent transport by drift reversal to realize improved confinement as have been experimentally demonstrated in axisymmetric configurations such as tokamaks and spherators[3-5].

The direct calculation of J is utilized in this study by following tracer particles. The validity of this scheme is checked by examining tokamak cases with different profile of safety factor, and the drift reversal is demonstrated as theoretically predicted for reversed shear case.

The local maximum of J is created for a vacuum case in a QA configuration to give favorable $dJ/dr<0$ at the edge region as hatched in Fig. 1. Here, r is the radial coordinate. This is due to the existence of non-axisymmetry of the magnetic field strength (B). This non-axisymmetry is locally pronounced on a magnetic surface depending on the amplitude, sign and phase of non-axisymmetric components of B. In a QA configuration considered in this paper, this local enhancement of non-axisymmetry is more influential for a tracer particle launched from around the half of the toroidal field period, $\zeta_N \approx 0.5$, on outer radius. A particle on outer radius loses parallel velocity largely by passing through this region to result in a decrease of J compared to J on inner radius. The toroidal extention of the local maximum of J is limited in an example QA configuration. This is because that the contribution from non-axisymmetry becomes less apparent for tracer particles launched from around the beginning of the toroidal field period, $\zeta_N \approx 0$, and inner radius at $\zeta_N \approx 0.5$, where J profile has unfavorable $dJ/dr>0$.

The finite beta modification of rotational transform profile, that is, the increase of shear in the core region, can give rise to a favorable $dJ/dr<0$ throughout the toroidal direction in that region. The region with $dJ/dr<0$ is widely expanded towards the core region with favorable contribution of the magnetic shear and also with the non-axisymmetry for an example finite beta equilibrium. The systematic investigations for finite beta equilibria with varying pressure profile would be valuable to examine whether $dJ/dr<0$ region can cover throughout a plasma.

External controllability of maximum-J region through magnetic configuration control based on proposed coil system is also demonstrated. This allows a systematic externally controlled experiments to test the importance of maximum-J condition to realize improved confinement, which enhances attractiveness and significance of an experimental device based on QA concept.

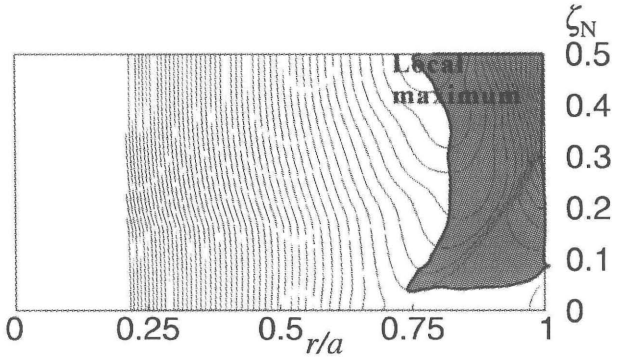

Fig.1

References

1)J.Nührenberg, W.Lotz and S.Gori, Theory of Fusion Plasmas (Proc. Workshop Varenna, 1994) Editrice Compositori, Bologna (1995) p.3.

2)S.Okamura et al., IAEA-CN-77/ICP/16, 18th IAEA Fusion Energy Conf., Sorrento, Italy (2000).

3)T.Fujita et al., in Plasma Physics and Controlled Nuclear Fusion Research 1996 (Proc. 16th Int. Conf. Montreal, 1996), Vol.1, IAEA, Vienna (1997) 227.

4)B.B.Kadomtsev and O.P.Pogutse, Nucl. Fusion 11 (1971) 67.

5)S.Yoshikawa, Nucl. Fusion 13 (1973) 433.