§ 27. Evaluation of Effective Ripple for CHS-qa Quasi-Axisymmetric Stellarator

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One of key physics targets in designing so-called advanced stellarators is to improve neoclassical confinement. In order to evaluate neoclassical transport in the $1/\nu$ regime for stellarators, an effective ripple ε_{eff} is often referred because neoclassical transport coefficient in the $1/\nu$ regime is expressed as a factor $\varepsilon_{eff}^{3/2}$. In this report, we describe ε_{eff} for quasi-axisymmetric stellarator CHS-qa. CHS-qa is being designed to provide good neoclassical confinement as well as magneto-hydrodynamic stability while realizing tokamak-like, toroidally-symmetric magnetic field structure. 1-2) The value of ε_{eff} is analyzed using the NEO code whose method is based on the integration along magnetic field lines 3) and the calculations are made for vacuum and finite β equilibria of CHS-qa.

Figure 1 shows values of $\varepsilon_{eff}^{3/2}$ as a function of r/a for three different cases i.e., 1. CHS standard configuration (R_{ax}=0.921m : vacuum), 2. CHS-qa ($<\beta>$=3.0% including neoclassical bootstrap current) and 3. CHS-qa (vacuum). 4) It can be seen that $\varepsilon_{eff}^{3/2}$ of CHS-qa is largely reduced. It is more than two order smaller compared with that of the existing conventional helical system CHS. The NEO code indicates that the neoclassical transport in the finite β equilibrium of CHS-qa becomes worse because of deterioration of "qa-ness" as β goes up. However, it should be noted that $\varepsilon_{eff}^{3/2}$ in the equilibrium of $<\beta>$=3.0% is still much smaller, by about two order, than that of CHS. Compared with W7-X, the profile of $\varepsilon_{eff}^{3/2}$ is relatively flat and its value is on the order of 10^{-3}.5) While $\varepsilon_{eff}^{3/2}$ in the peripheral region of CHS-qa is comparable with that of W7-X, it is much smaller, by about two order at r/a=0.2, than that of W7-X. The NEO code suggests that in a viewpoint of neoclassical transport in the $1/\nu$ regime, the CHS-qa configuration has significant advantage to CHS as expected. It also shows that the neoclassical transport coefficient in CHS-qa does not exceed that in W7-X until at least $<\beta>$ up to 3%.

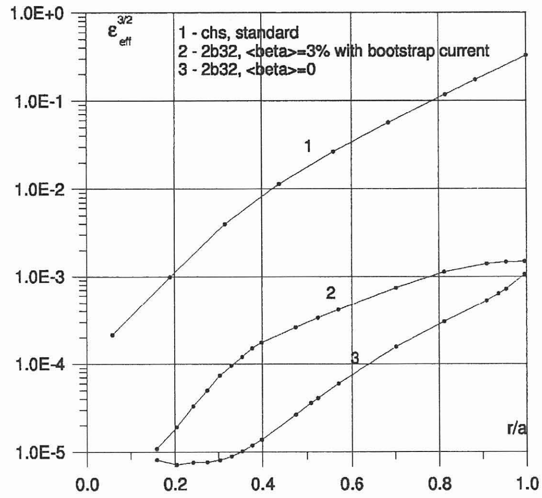

Figure 1. Profiles of $\varepsilon_{eff}^{3/2}$ for 1. CHS (R_{ax}=0.921m : vacuum), 2. CHS-qa ($<\beta>$=3.0% including neoclassical bootstrap current) and 3. CHS-qa (vacuum)

References

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