3D effects to stochasticiy in non-axisymmetric tori

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The stochastization due to the 3D effect is an intrinsic property in stellarators. The 3D effect is a reaction of the pressure-induced perturbed field, which is produced by the parallel current flow along 3D field lines. Since the stochastization leads the degradation of the confinement, the study of the stochastization is important to aim the reactor.

Most important parallel current in stellarators is the Pfrish-Schlüter (P-S) current to keep the equilibrium force balance. Using 3D MHD equilibrium codes without the assumption of nested flux surfaces in *a priori*, which are HINT/HINT2 [1,2] and PIES [3] codes, the 3D effect was studies. In a conventional heliotron, field lines in the peripheral region became strongly stochastic for the net-current free equilibrium [4]. In an advanced stellarator, the stochastization was not large but large magnetic island appeared because of the weak magnetic shear [5]. Sometimes, the 3D effect suppressed such magnetic islands, so-called 'self-healing' [5,6]. In previous studies of the 3D effect, the parallel current was assumed only the P-S current. However, since the net-toroidal current was observed in many experiments, the study of the 3D effects driven by other parallel currents, which are bootstrap current, NBCD and ECCD, is an urgent issue.

Figure 1 shows a result of the 3D MHD equilibrium analysis for an LHD configuration using the HINT2 code. For the comparison, the vacuum flux surfaces are also shown. Some poloidal cross section along the toroidal angle ϕ are plotted. For the vacuum, clear flux surfaces are kept in the inside of the separatorix. However, for a finite-β equilibrium, magnetic field lines become stochastic in the peripheral region. Since this stochastization will leads the degradation of the confinement property, understanding and controlling of the stochastization are very important.

On the other hand, the effect of the stochastic field is also a hot topic in tokamak studies. Superposing the stochastic field to the plasma, there is a possibility to mitigate or eliminate the edge localized mode (ELM) [7,8]. To model the field configuration superposed the stochastic field, the vacuum approximation, which is the 2D MHD equilibrium with nested flux surface superposed the vacuum 3D perturbed field, are widely used. However, this model does not include the response from the plasma and its stochasticity is always fixed for the vacuum. Since it is expected the parallel current flow along rippled field lines causes the 3D effects, the study of the 3D effect is also an important issue in tokamaks as well as stellarators.

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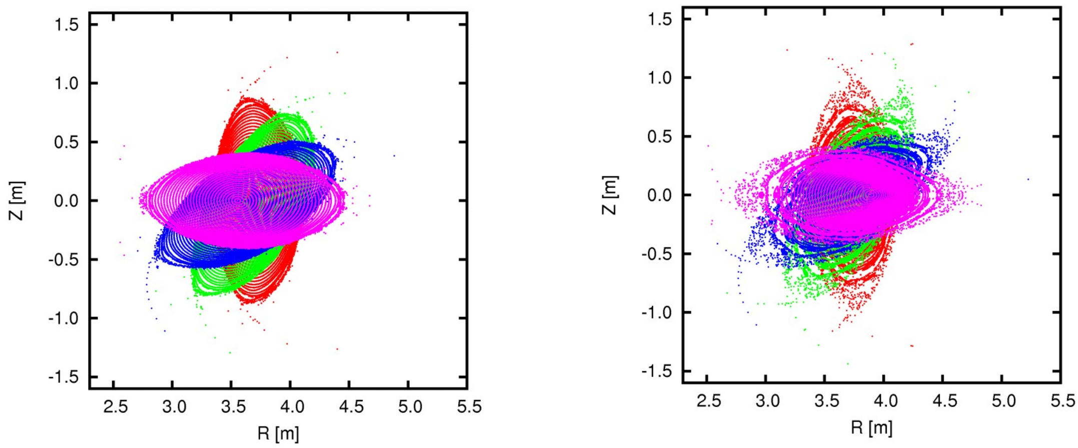

Figure 1. Puncture maps of magnetic field lines in an L=2 heliotron are plotted for the vacuum (left) and finite-β equilibrium. Some poloidal cross sections are plotted along the toroidal angle ϕ.