1-D Transport Simulation for a 3-D MHD Equilibrium

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Several 1-D transport code simulation studies have been done for non-axisymmetric toroidal plasmas such as stellarators (or helical systems). Many of these studies adopted the cylindrical approximation similar to the circular tokamak cases. Transport simulations for non-circular tokamak plasmas can be done by a combination of the 1-D transport code and the 2-D MHD equilibrium code, so called 1.5-D transport code. In the same sense, several 1D transport simulations combined with a 3-D MHD equilibrium code have been performed in helical systems. Most of these studies use the specific volume and neoclassical ripple transport coefficients calculated from the data obtained by the VMEC 3-D MHD equilibrium code, which is a 3-D inverse solver based on the variational principle.

In this talk, we will briefly review 3-D MHD equilibrium calculations and 1-D transport simulations for helical systems, and will discuss some difficulties and problems to be resolved. As an example, Fig.1 shows an MHD equilibrium of an L=1 helical-axis heliotron, Heliotron J (H-J) calculated by the PIES code, which can calculate a 3-D MHD equilibrium without assuming the existence of nested flux surfaces. It is shown in Fig. 1 that magnetic islands can exist in 3-D MHD equilibria of stellarator plasmas and they will affect transport like NTMs in tokamaks.

Not only for the helical systems, ripple loss or diffusion of alpha particles is one of the important issues on tokamak fusion reactors. It has been pointed out from the 3-D MHD equilibrium calculation for the rippled tokamak that ripple structure can be changed in the finite beta plasmas. Finite beta effects on the alpha ripple loss will also discussed.

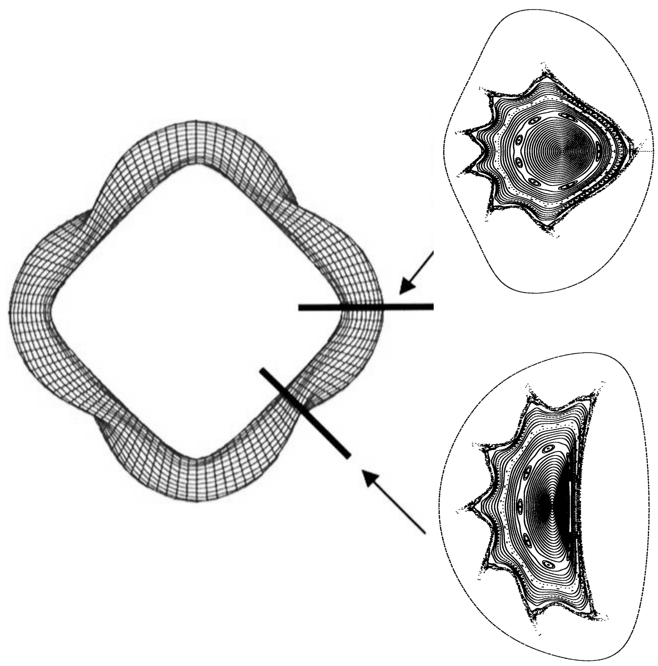

Fig.1 Top view and puncture plots of an MHD equilibrium in the Heliotron J calculated by the PIES code