Development of 3D equilibrium code and its application to stellarators

Yasuhiro Suzuki[1], Shimpei Futatani[2]

[1] *Hiroshima University, Higashi-Hiroshima, Japan*

[2] *Polytechnic University of Catalonia, Barcelona, Spain*

The flux surface is fundamental to confine the fusion plasma, so the magnetic field in the magnetic confinement fusion has been designed to keep nested flux surfaces. However, from many theoretical and experimental studies, the topological change of the magnetic field, that is, the magnetic island or the stochastization of the magnetic field, can be applied to control the transport and MHD. For example, in the active control of tokamaks, the Resonant Magnetic Perturbation (RMP) field breaking the nested flux surfaces applied to control the high energy heat and particle fluxes by the Edge Localized Mode (ELM). As another example, the magnetic island and stochastic field are applied for the advanced divertor concept in stellarators. Therefore, for the advanced stellarator configuration in the future reactor, it is necessary to simultaneously consider not only the keeping of nested flux surface but also the topological change of the magnetic field such as the magnetic island and stochastic field.

A key issue to design the advanced stellarator configuration is the 3D equilibrium because the magnetic field line is very sensitive to the 3D equilibrium response. In recent advances of 3D equilibrium studies, it is found that the plasma pressure and toroidal current density profiles have significant impacts on the topology of the magnetic field in the 3D equilibrium. From 3D equilibrium calculations, the self-healing or amplification of the magnetic island is found. Also, those profile effects lead to the strong stochastization of the magnetic field in the plasma edge.

In this talk, the development of the 3D equilibrium calculation and its applications to the advanced magnetic configuration design. At first, recent advances of the 3D equilibrium calculation are discussed for the HINT, an initial solver based on the relaxation method without the assumption of the nested flux surface. The impact of the 3D equilibrium response for the advanced stelarator configuration, especially the divertor configuration, is discussed.