Anisotropic heat diffusion on stochastic field lines of LHD

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The magnetic topology is a key issue in fusion plasma researches. An example is the Resonant Magnetic Perturbation (RMP) to control the transport and MHD activities. However, the physics how the RMP affects the transport and MHD is not clear. One reason is the change of the magnetic topology by the plasma response. Since the vacuum approximation cannot interpret experimental observations in many cases, the magnetic topology might be changed by the plasma response. In addition, the change of the magnetic topology is predicted by numerical simulations. However, the identification of the magnetic topology in the experiment is very difficult.

Recently, ideas to identify the magnetic topology experimentally are proposed in the LHD experiment. Those are the heat pulse propagation by modulated ECH and measurements of the radial electric field. However, those techniques give only one dimensional profiles. In the peripheral region of LHD, the magnetic field structure is very sophisticated because island chains are overlapped by strong magnetic shear. Thus, the heat pulse propagation and radial electric field might be distributed by two- or three-dimensionally. To see that, the tomographic method is necessary.

In this study, we study the anisotropic heat diffusion given by a following equation,

$$\frac{\partial T}{\partial t} = \nabla \cdot (\kappa_{\parallel} \nabla_{\parallel} T + \kappa_{\parallel} \nabla_{\perp} T) + Q,$$

to simulate the tomographic image of the heat pulse propagation. Changing a ratio of $\kappa_{\parallel}$ and $\kappa_{\perp}$, the distribution of the temperature on the stochastic magnetic field is obtained. Hudson et al pointed out the KAM surface is a barrier to keep the finite temperature. We simulate those results in realistic magnetic field of the LHD.