Nonlinear modeling of the effect of multi-locked modes on heat transport

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Experimental evidence of the formation of multiple helicity island chains during the locked mode phase preceding plasma disruption is observed on DIII-D [1]. To understand the experimental results, nonlinear numerical modeling of multi-components (m/n = 2/1, 3/1, 4/1 etc) resonant magnetic perturbations (RMPs) penetration has been studied based on reduced MHD equations. It is found that after field penetration, the non-rotating magnetic islands, having helicity of 2/1, 3/1 and 4/1, flatten the temperature at the corresponding rational surfaces, and the co-existence these islands significantly enhances the plasma heat transport from q = 2 rational surface to plasma edge. As a result, the core temperature is decreased by more than 50% in a time scale of 100 ms. In addition, the temperature profile from 2/1 to 4/1 rational surface can be nearly flattened even if there is no island overlap, and the temperature inside the islands are determined by outboard separatrix of the island. The mild increase of RMP amplitude leads to an island overlap between 3/1 and 4/1, and further induces the rapid cooling the temperature inside 2/1 rational surface. The results indicate that by the presence of error field of application of RMPs, the plasma is susceptible to multi-helicity locked modes. These island chains further deteriorate plasma thermal confinement, which may be responsible for the fast thermal quench proceeding plasma in major disruption.

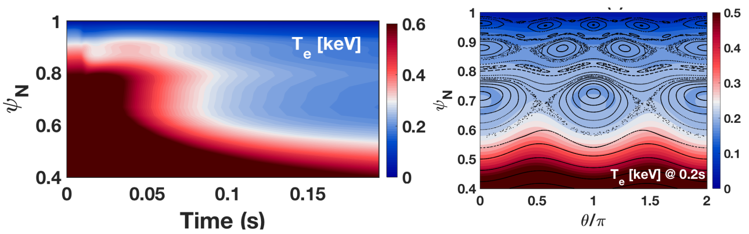

Fig. Time evolution of T_e profile and 2D profile of T_e together with magnetic flux surface.

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[1] Du X.D., et al, *A Key Role of Multiple, High-order, Small Locked Island Chains in Triggering Plasma Major Disruption in DIII-D tokamak*, **to be submitted**.