Observations of Transitions Between Nested and Braided Magnetic Island in DIII-D and LHD*

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Measurements of modulated heat pulse propagation in DIII-D have revealed the existence of self-regulated oscillations in the radial energy transport that are indicative of bifurcations in the structure of a q=2 magnetic island. Strong screening of the heat pulse is seen in one state followed by weak screening later in the discharge. The magnetic island with strong screening is interpreted as having a narrow stochastic region near X-point with nested flux surfaces occupying most of the island (a completely nested island), where very slow heat pulse propagation suggests a reduction of transport. Weak screening of heat pulse suggests a wide stochastic region near the X-point and a small region of nested flux surfaces inside the island (partially braided magnetic island).

The reduction of heat transport observed inside magnetic island has recently been reported both in helical and tokamak plasmas [1,2]. In the LHD experiment, there are two patterns of heat pulse propagation observed in the flat temperature region. One is a bi-directional slow heat pulse propagation and the other is a fast heat pulse propagation. This bifurcation in the heat pulse propagation is consistent with a topological transition between a nested magnetic island and a completely braided magnetic island in LHD and is consistent with the DIII-D measurement.

In the DIII-D experiments, the radial heat transport is either enhanced or reduced depending on the state of the island, because the radial transport is reduced inside O-point region while it is enhanced near the X-point region. These results demonstrate that the structure of magnetic islands can spontaneously transition during a discharge and modulate the local energy transport inside magnetic island by at least a factor of three.

[1] S. Inagaki et al., Phys. Rev. Lett. **92** (2004) 055002.
[2] K. Ida et al., Phys. Rev. Lett. **109** (2012) 065001.

*Supported in part by the US DOE under DE-FC02-04ER54698, DE-FG03-97ER54415 & DE-AC05-00OR22725.