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Comparative Studies of Edge Magnetic Islands and Stochastic Layers in DIII-D and LHD

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Joint experiments on the DIII-D tokamak and the LHD stellarator/heliotron have resulted in the discovered of spontaneous heat transport bifurcations across the O-point of an applied m/n=2/1 magnetic islands in DIII-D and enhanced particle transport relative to heat transport in edge m/n=1/1 LHD isalnds. The DIII-D results suggest that the heat transport bifurcations are due to islands transitioning from smooth flux surfaces to partially stochastic layers. Alternatively, measurements of the particle and heat transport inside edge static magnetic islands in LHD plasmas show an enhancement of the particle flux relative to the heat flux. The DIII-D results suggest that externally applied static 3D magnetic fields can produce a dynamic evolution of the magnetic topology in the plasma due to a nonlinear toroidal coupling of resonant modes on various rational surfaces while the LHD results show that edge magnetic islands preferentially increase the particle flux relative to the heat flux for reasons that have yet to be clarified.
Static magnetic islands and stochastic layers have been observed in low-β L-mode plasmas but not in diverted H-mode plasmas yet. In order to understand the physics of non-axisymmetrically perturbed high-β fusion H-mode plasmas, such as the mechanisms involved in edge localized mode (ELM) suppression with resonant magnetic perturbation (RMP) fields, it is necessary to determine if islands and stochastic layers exists and whether they are static or evolve in time due to the plasma response. Measurements in DIII-D show spontaneous transitions of the magnetic field on rational surfaces due to the plasma response. For example, flat spots in the T_e profile associated with m/n = 2/1, 3/1 and 4/1 islands are seen to appear and disappear as the discharge evolves suggesting either a time varying screening of the field by the plasma or a nonlinear coupling of the 2/1, 3/1 and 4/1 islands. In this contribution we discuss the measurements made in DIII-D along with transport results due to pellets injected into static islands in LHD and their implications for understaning the plasma response to 3D fields in H-mode plasmas.

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