§10. Island Formation in 3D Equilibria of Helical Plasmas (Extension of the HINT Code)

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Confinement nature of an edge plasma is largely influenced by the structure of magnetic surfaces in the boundary region. This issue is of particular importance for non-axisymmetric tori. The three dimensional (3D) MHD equilibrium code HINT has been developed to answer the indeterminate question of whether or not a 3D finite pressure equilibrium can really exist[1,2]. It has been extensively used to analyze properties of helical equilibria, such as Heliotron/Torsatron [3-5], Helias [5,6], and Heliac [7]. One important discovery obtained is that magnetic surfaces are ergodized by the finite pressure effect in actual helical configurations, and the ergodization of surfaces in the core region often imposes severer limitation on the equilibrium beta than the Shafranov shift. The breaking of surfaces often grows in the boundary region in particular. Also found by HINT is a remarkable property of `self-healing' of magnetic islands as beta increases. [5,6,8].

We have modified the HINT code in a couple of directions to extend the functions [9,15].

1) The code is modified so that coil currents can exist in the computation region.
2) The net toroidal current effect as well as the full torus configuration can be consistently treated in the evaluation of the island formation. [10-12]. The n=1/m=1 local island diverter configuration and the whisker field structure in finite pressure equilibria of LHD are studied by using the full torus version of HINT [16].
3) A nonlinear simulation code in full three-dimensional geometry of helical plasmas based on the HINT code is developed. Nonlinear dynamics of plasma behavior induced by growth of resistive ballooning instability in the LHD geometry is studied [13,14].

New series of computations are executed (Heliotron-J, W7AS, CHS-qa, H1-Heliac), which became achievable by the modification of the code to have existence of coil currents in the computation region. Usefulness of the code has largely increased.

Based on those HINT computations, the importance of the global effect' physics in the mechanism of island formation for 3D equilibrium, which is not predicted quantitatively by the previous analytical theories, is confirmed clearly by equilibrium computation for a high hill configuration (see Fig.1).

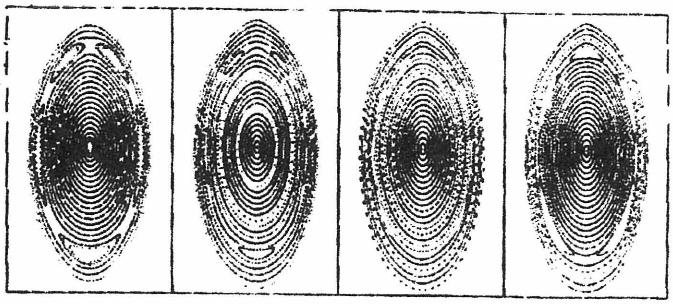

Fig. 1 Equilibrium computation for a High Hill Helias. The configuration has a strong hill. The panels show the process of self-healing of magnetic island, where beta increases from left to right.

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