§4. Fourier Mode Anaysis of Numerical Results Obtained by Direct Numerical Simulation of MHD Under LHD Inward-shifted Configuration

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Direct numerical simulation (DNS) of three-dimensional (3D), compressible and nonlinear magnetohydrodynamic (MHD) equations are carried out to study plasma stability in the LHD under inward-shifted configuration. For the purpose of the analysis of DNS results in the framework of linear analysis, the Boozer coordinate is constructed by making use of VMEC2000 code. We show below that the full 3D natures of the MHD equations are vital to investigate the plasma stability, while some portions of the linear growth may look similar to the pictures obtained by the reduced set of MHD equations.

Our DNS starts form an initial equilibrium obtained by the HINT computation.1) Position of the vacuum magnetic axis is set to 3.6m. The pressure profile is sharp around the magnetic axis, having the central beta=4%. Because of the peaked profile, the initial equilibrium has D_I > 0 for wide range of the torodial magnetic flux Ψ. Thus it is expected that the dynamical evolution of MHD equations shows strongly unstable behaviors. Below, we see numerical results of one run, in which the heat conductivity, resistivity and viscosity are set to 10-6, 10-6 and 2x10-3, respectively. The number of grid points are 97x97 in the poloidal section and 640 in the toroidal direction.

In Fig. 1, the mean pressure profile (m/n=0/0) and rotational transform of the initial equilibrium are shown, where m and n are poloidal and toroidal Fourier wave numbers, respectively. The abscissa is normalized so that it represents the beta value at the origin.

In Fig. 2, the growth of the power spectrum of the pressure, |Pmn(Ψ)|2. The exponential growth of m/n=1/1 and 2/1 Fourier modes are observed. The growth of m/n=2/1 mode is consistent with the observation in Fig.2. Because of the residue in the HINT computation, m/n=0/1 mode has a small but finite amplitude. Consequently, m/n=1/1 mode grows as the side band of m/n=2/1 mode. The growth of the Fourier modes are saturated after the multiple number of modes grow sufficiently.

In the saturated state, toroidal flow is as strong as poloidal flow. We observe that the toroidal flow and compressibility consist of essence of the dynamical evolution of the plasma in LHD. The numerical results were reported in the IAEA Fusion Energy Conference, Villamoura, Portugal, November 2004.[1)]

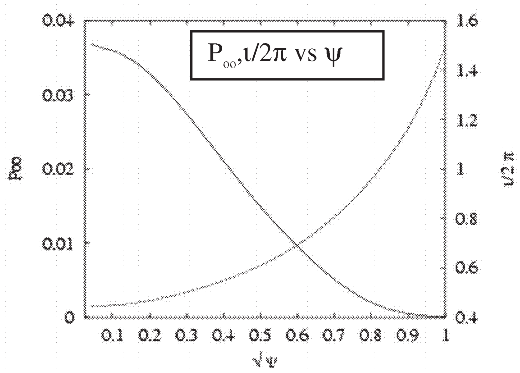

Fig. 1. Mean pressure profile (m/n=0/0) and the rotational transform of the initial equilibrium.

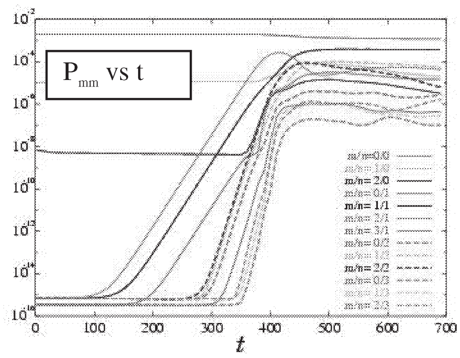

Fig. 2. Time evolutions of the Fourier power spectra of the pressure.

1) H. Miura, K. Ichiguchi, N. Nakajima, T. Hayashi and B. Carreras, *Non-disruptive MHD Dynamics in Inward-shifted LHD Configurations*, (20th IAEA Fusion Energy Conference, Villamoura, Portugal, 1-6 November 2004, IAEA-CSP-25/CD/TH/2-3, ISBN 92-0-100405-2)