§1. Fourier Modes Evolution in 3D MHD Instability of LHD

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We have been carrying out direct numerical simulations of fully three-dimensional, nonlinear MHD in the LHD. An initial condition with the $\beta_0 = 4\%$ and $R_{ax} = 3.6m$ has been provided by using the HINT code[1]. We report here time evolutions instability through a simulation with the resistivity $\eta = 1 \times 10^{-6}$, the viscosity $\mu = 1 \times 10^{-6}$, the isotropic heat conductivity $\kappa = 1^{-6}$, which are much smaller than the values adopted in our earlier work.[2]

For the purpose of studying the Fourier mode growth of the three components of the velocity vector, the vector is decomposed into the parallel ($v^{\boldsymbol{b}}$), normal ($v^{\nabla\psi}$) and binormal ($v^{\nabla\psi\times\boldsymbol{b}}$) components. In Fig.1, time evolutions of the amplitudes of some Fourier modes, associated with the $\iota/2\pi = 1/2$ rational surface, of the normal, parallel and binormal components are shown. The Fourier amplitudes of these modes grow exponentially because of the linear (pressure-driven) instability. The growth rates become larger for larger n, as is expected from the nature of the pressure-driven instability. The growth rates of the $n = 1$, 2, 3 and 4 modes are 0.176, 0.1965, 0.2155 and 0.216 by our direct numerical simulation, while they are estimated as 0.1789, 0.239, 0.2613 and 0.2686, respectively, by the CAS3D computation. While the growth rates of our simulation and the CAS3D computation coincide well with each other for $n = 1$, the difference becomes larger for larger n due to the dissipative nature of the direct simulations.

In Fig.2, some Fourier modes of the normal component of the velocity vector in their linear growth stage are plotted as the functions of the square root of the toroidal ux ψ. The $m/n = 12/7$ Fourier mode has the largest amplitude. Since the second strongest mode $m/n = 11/7$ is asymmetric to the peak position of the $m/n = 12/7$ mode, it appears more like the ballooning-mode structure than the interchange mode. The Fourier mode behaviors should be further studied with more high accuracy simulations.

The numerical results were presented in the Joint Varenna-Lausanne International Workshop, Varenna, Italy in September 2006.[3]

1) H. Harafuji, T. Hayashi and T. Sato, J. Comp. Phys., **81** (1989) 169.

2) H. Miura, N. Nakajima, T. Hayashi and M. Okamoto, Fusion Science and Technology **51** (2007) 1095.

3) H. Miura, N. Nakajima, T. Hayashi and M. Okamoto, THEORY OF FUSION PLASMAS, AIP Conference Proceedings Vol.871 (2006).

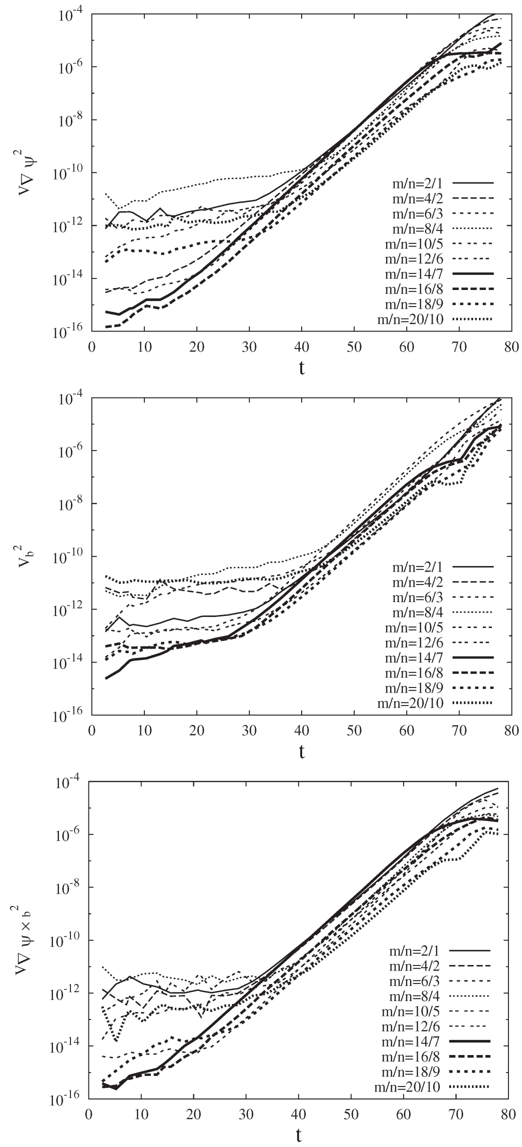

Fig. 1: Time evolutions of the amplitudes of the $m/n = 1/1$ and $2/1$ Fourier modes of the normal, parallel and binormal components of the velocity.

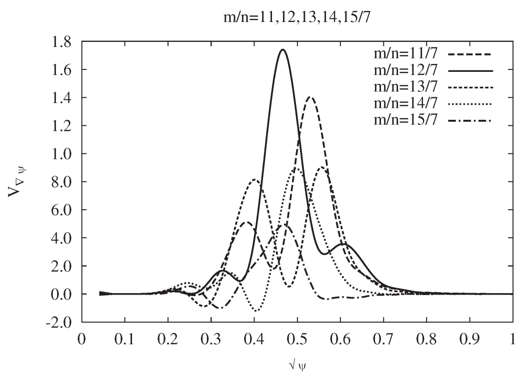

Fig. 2: The normal component of the velocity vector in their linear growth stage.