

## §1. Theoretical Study on Self-organization in a Spherical RFP

Sanpei, A., Fujita, S., Masamune, S., Ikezoe, R., Onchi, T., Oki, K., Shimazu, H., Yamashita, T., Konishi, Y., Sugihara, M. (Kyoto Inst. Tech.), Kondoh, Y., Takahashi, T., Nakajima, R., Yagi, T., Iizima, F., Ikeda, T. (Gunma Univ.), Mizuguchi, N.

We have been carrying out direct numerical simulations<sup>1)</sup> of the fully three-dimensional, nonlinear magnetohydrodynamics (MHD) equations in a low aspect ratio ( $A$ ) reversed field pinch (RFP) plasma. The low- $A$  RFP has the advantage of simpler MHD, because the mode rational surfaces are less densely spaced. One of our research purposes is analysis of MHD properties of low- $A$  RFP. In this study, all calculations assume the following parameters of the low- $A$  RFP device, REversed field pinch of Low Aspect eXperiment (RELAX):<sup>2)</sup>  $R/a = 0.51$  [m]/ $0.25$  [m],  $A = 2$ . The device is operated with a 4 mm SS vacuum vessel (field penetration time  $\tau_w < 3$  ms), where  $R$  is the major radius and  $a$  is the minor radius. In the RELAX experiment, growth of fluctuations is considered to be dominated by kink mode  $m = 1$ <sup>3)</sup>.

Here we report our preliminary numerical results obtained by a MHD simulation to study the MHD properties of low- $A$  RFP. An initial condition has been provided by using the modified MSTFit code<sup>4)</sup> for the low- $A$  RFP by changing the boundary conditions, from several external diagnostics on RELAX<sup>5)</sup>. We adopt resistivity  $\eta$ , the viscosity  $\mu$ , and the isotropic heat conductivity  $\kappa$ , are assumed to be uniform values of  $1.0 \times 10^{-9}$ ,  $1.5 \times 10^{-4}$  and  $1.0 \times 10^{-9}$ , respectively. The simulations with these parameters are carried out for a set of the grid points,  $57 \times 68 \times 57$ . The boundary condition is put as a perfect-conducting and no-slip wall at all boundaries of the computation region, as shown in Fig.1

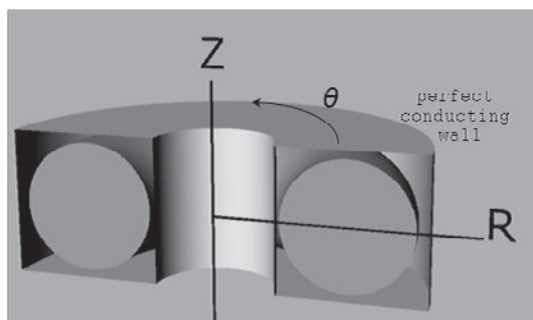


Fig. 1: The schematic of geometry of the computation region.

Shown in Fig.2 is the time evolutions of the perturbation in magnetic energy for each toroidal Fourier com-

ponent. This computational result that  $n = 4$  mode is dominant is consistent with experimental result<sup>3)</sup>. Moreover, another feature is that the relative amplitude of  $n = 8$  mode is non-negligible, as shown in Fig.2. Our experimental results<sup>3)</sup> suggest that  $m = 2$  mode is non-negligible which is usually ignored in high- or medium- $A$  RFP plasmas. Figure 3 shows the pressure profiles on poloidal cross section of  $m/n = 1/4$  and  $2/8$  at  $t = 350 \tau_A$ , respectively. Nonlinear coupling between the dominant  $m = 1$  modes have been considered to be the origin of  $m = 2$  mode, however more detailed study of relations between origin of  $m = 2$  mode and lowering  $A$  remains as a future work.

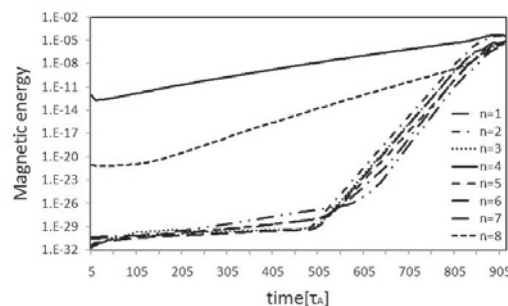


Fig. 2: Time evolutions of the Fourier-amplitudes of the magnetic fluctuations.

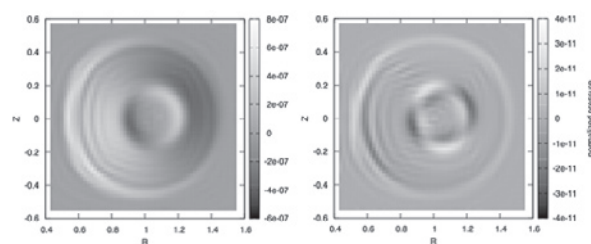


Fig. 3: Pressure profiles of  $m/n =$  (a)  $1/4$  and (b)  $2/8$  at  $t = 350 \tau_A$ .

In order to clarify the effect of mesh size, the computation with larger number of grid points,  $113 \times 68 \times 113$  is now underway.

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