Simulation Study on Resistive Instabilities in Spherical (or Low Aspect Ratio) Reversed Field Pinch

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The dynamical behavior of resistive instabilities in the spherical (or low aspect ratio) reversed field pinch (RFP) plasma was studied using a three-dimensional magnetohydrodynamic (MHD) simulation model. As for the conventional RFP with larger aspect ratio, recent numerical simulations showed the possibility of reproducing the single-helicity states, which were considered to achieve better confinment perfomances in the RFP experiment [1]. In the RFP experiment with aspect ratio A=2, formation and rotation of the helical structure such as quasi-single-hericity states have been observed [2]. Towards the understanding of this structure formation mechanism, analysis using the detailed three-dimensional MHD simulation through the comparison with the experiment has been conducted [3].

In this study, from an analogy with the spherical tokamak (ST), we focus our attention on the RFP configuration having an elongated cross section with aspect ratio A < 2, namely spherical RFP, and examine the basic characteristics of the equilibrium configuration and behavior of the resisitive MHD instability. Regarding the spherical RFP configuration, its characteristic already has been pointed out shortly in the first theoritical study on the spherical tokamak (Peng & Strickler [4]).

Since a stabilizing shell located near the plasma surface is necessary to sustain the RFP configuration, it is considered that it is not easy to develop spherical RFP device with a non-circular cross section like the ST. In addition, as the reactor, the extreme lowering of the aspect ratio becomes disadvantageous from the viewpoint of neutron irradiation of the torus center region. However, considerably high beta plasmas were attained in the ST than the conventional standard tokamak. With respect to the RFP, it is considered that the theoretical prediction of plasma properties such as the resistive instabilities in the ultra low aspect ratio regime is greatly important.

[1] Onofri M, *Nuclear Fusion* **51**, 112003 (2011).
[2] Oki K, *et al*., *J. Phys. Soc. Jpn.* **77**, 075005 (2008).
[3] Mizuguchi N, *et al*., *Plasmas Fusion Res.* **7**, 2403117 (2012).
[4] Peng Y-K M and Strickler D J, *Nuclear Fusion* **26**, 769 (1986).