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極低アスペクト比逆磁場ピンチプラズマにおける抵抗不安定性のMHD解析
Simulation study on resistive instabilities in a small aspect ratio reversed field pinch

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A reversed-field pinch (RFP) plasma is the result of a self-organization process, which is produced by a dynamo effect due to magnetohydrodynamic (MHD) instabilities. In the recent progress of the RFP study, improvement of the confinement properties by the transition to a single-helical-axis state is observed in the large experimental device. Also recent numerical simulations show the possibility of reproducing such single-helical-axis states [1]. As for a low aspect ratio RFP with A≈2, formation and rotation of the helical structure such as quasi-single-hericity states have been observed in experiments [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 a small aspect ratio A < 2, in other words, spherical RFP. The basic characteristics of the equilibrium configuration and dynamical behavior of resistive instabilities are examined by using the MHD simulation model. Regarding the spherical RFP concept, its characteristic already has been introduced briefly in the first theoritical study on the spherical tokamak [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 and the search for the beta limit condition in this small aspect ratio regime are much important.

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