§43. Role of Kinetic Effect on a Stability of High-beta Torus

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1. Introduction

A field-reversed configuration (FRC) plasma is generally formed using the formation techniques as a field-reversed theta pinch (FRTP), a spheromak merging and a rotating magnetic filed (RMF) and has been experimentally studied at Nihon University (FRTP, translation), Osaka University (translation, RMF) Kansai University (RMF) and University of Tokyo (merging). These FRC plasmas have very wide range of parameter value *e.g.* density: 10^{19} - 10^{21}m^{-3}, temperature: 10 - 1keV. In this work, we have aimed to discuss about the ion kinetic effect on these wide range of experimentally generated FRC plasmas. A FRC is the only torus confinement system which has nearly unite of beta value. Therefore, ions have large normalized Larmor radius in a system. This feature is will be appeared in a burning state in low-beta torus systems. Thus, a FRC can simulate a physics of burning state of tokamaks and helical system and at the same time is candidate of a future high performance reactor core.

2. Results

In the translated FRC plasma, global instability, especially rotational instability with toroidal mode number n = 2 has not been observed despite it is destructive instability conventional FRCs formed by FRTP methods. To investigate a role of kinetic effect of injected background neutrals into a translated FRC, numerical simulation and comparative discussion have been performed [1].

The toroidal spin-up of ions which effects on a global instability of FRC has also been studied with newly proposed mechanism [2), 3)]. Figure 1 show calculated ion toroidal flow in a poloidal plane. This work indicates the possibility of ion spin-up by decaying of poloidal flux. Transition of ion trajectory in a decaying field is shown in Fig.2. This result has been compared with experimental results and shows good agreements of the actual spin-up rate obtained ion Doppler spectroscopy (IDS). Numerical simulation of flute mode fluctuation and transport has also been started by Katanuma et al [4].

In the experiment side, low-energy and high power NBI system with stainless-steel washer gun has been developed to study a kinetic effect of high temperature ions in a FRC. The system has been designed with unique features e.g. comparatively low energy (~15keV), large current (~30A) and employing washer gun as a initial plasma source.

3. Summary

Based on these theoretical and experimental investigations, experimental plan for the steady state FRC operation has been constructed. The summary of achievements will partially be presented in a feature article of journal of plasma and fusion research.

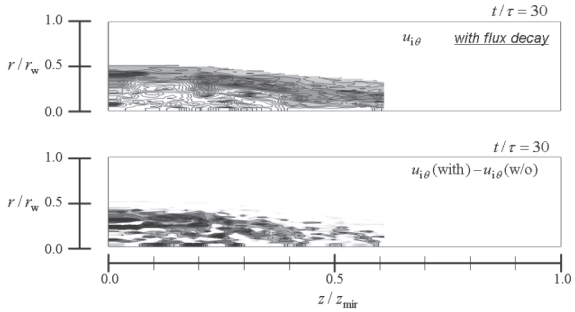

Fig. 1. Poloidal profile of calculated ion toroidal flow.

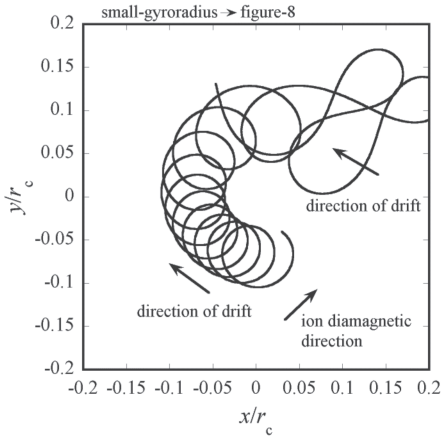

Fig. 2. Transition of ion trajectory in a decaying confinement magnetic field.

1) Asai, T., Matsuzawa, Y., Yamamoto, N. *et al*, Trans. Fusion Sci. Tech. 51, (2007) 379.
2) Yamaura, H., Takahashi, T., Kondoh, Y. et al., Trans. Fusion Sci. Tech. 51, (2007) 373.
3) Takahashi, T., Yamaura, H., Iizima, F. *et al*., Plas. Fus. Res. **2**, (2007) 008.
4) Katanuma, I., Saimaru, H., Mizoguchi, Y. et al., in 17th international Toki conference (2007) p2-057
5) Asai, T., Yamaguchi, N., Kajiya, H. et al., Rev. Sci. Instrum. 79, 063502 (2008).