26aE15P

ヘリオトロンJにおける新古典輸送・ブートストラップ電流解析
Numerical analysis of neoclassical transport and bootstrap current in Heliotron J

西岡賢二[1], 中村祐司[1], 西村伸[2]
Kenji Nishioka[1], Yuji Nakamura[1], and Shin Nishimura[2]

[1]京大エネ科　[2]核融合研
[1]GSES, Kyoto University, [2]NIFS

In non-axisymmetric plasmas, plasma currents are not required for generating the rotational transform. However, the bootstrap current, one of the non-inductive currents, is caused due to the existence of particles trapped in magnetic ripples and radial gradients of the plasma pressures. For the numerical estimation of this current, the SPBSC code has been applied for the estimation in Heliotron J plasmas [1]. This research has been shown the controllability of bootstrap currents by changing the magnetic field configuration. Furthermore, the bumpy field dependence taking account of the ambipolar electric field is carried out by using the Sugama-Nishimura's moment approach [2]. However, above investigations did not discuss about the behavior of the bootstrap current in collisionless plasmas. In the low collisionality regime, positive ambipolar electric field (electron root) is predicted. Moreover, the finite multi-ion species effect between ions is expected because friction-interaction between ions becomes much smaller. Thus, we investigate those effects in this research.

We calculated the bootstrap current in the standard configuration of Heliotron J. We set the $n_e(=n_H)$ and T_H as $n_e(s)=1.5\times10^{19}\left(1-s^3\right)\mathrm{m}^{-3}$ and $T_H(s)=150(1-s)^2\,\mathrm{eV}$, respectively. The bootstrap current in $T_e(s)=400(1-s)^2\,\mathrm{eV}$, $T_e(s)=600(1-s)^2\,\mathrm{eV}$, and $T_e(s)=1000(1-s)^2\,\mathrm{eV}$ plasmas are shown in Fig.1(a). This denotes that the change in direction of the bootstrap current is predicted in electron roots. Figure 1(b) indicates that the change in the geometric factor of the bootstrap current $G_a^{(\mathrm{BS})}$ with the ambipolar condition should be taken into account for the consistent estimation of the bootstrap current in strong $|E_r|$ cases. The detailed analysis of the multi-ion species effect, the radial transport, and the influence of the bootstrap current on the magnetic configuration is now under investigation.

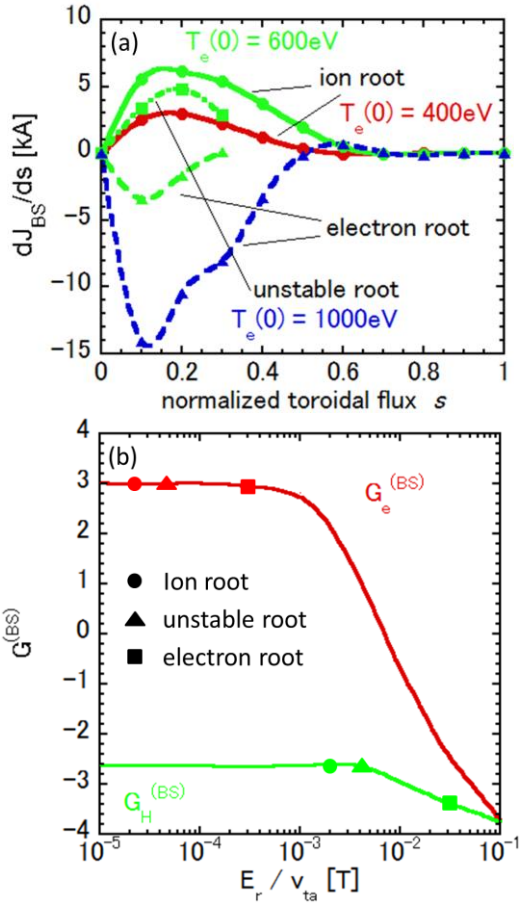

Fig. 1: (a) Radial dependence of the bootstrap current under several ambipolar conditions. (b) Dependence of $G_a^{(\mathrm{BS})}$ for electron and proton on $|E_r|$ at $s=0.1$ in the $T_e(0)=600\mathrm{eV}$ plasma.

[1] Y. Nakamura, et al, Fusion Sci. Tech. **50**, 281 (2006)
[2] K. Nishioka, et al, Plasma Conference 2014, 21PA-040