Simulation study of toroidal flow generation by ICRF minority heating

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Important role of the plasma flow and its shear in the transport improvement is suggested by many experimental observations. The spontaneous toroidal flow has been observed during ICRF heating with no direct momentum input in JET, Alcator C-mod and etc. [1]. Many theoretical studies have been done, however, further study is necessary to make clear the generating mechanism.

In this paper the toroidal flow generation by the ICRF minority heating is investigated in the Alcator C-mod like plasma applying GNET code [2, 3], in which the drift kinetic equation is solved in 5D phase-space. The simple model for RF wave field is assumed in this study. A steady state distribution of energetic minority ions is obtained balancing the source and sink terms of the particle and energy in the 5D phase-space.

We perform the simulation using GNET code assume the following plasma parameters; n_{e0}~8×10^{19}m^{-3}, T_0~3.2keV and B_0=5.4T. The minority ions are accelerated perpendicular direction by the RF wave interaction and we can see a tail ion formation due to the ICRF heating. Interestingly we can see strong asymmetry in the parallel velocity direction and the averaged minority ion toroidal velocity up to 0.3 of the central thermal ion velocity is obtained. We also show that there exist two kinds of toroidal flows. One is the sheared flow near the RF power absorption region depending on the sign of $k_{//}$ and the other is the toroidal flow, which is larger than the previous one, independent of the sign of $k_{//}$.

It is found that the $k_{//}$ sign dependent flow would be related to the mechanism proposed by Ohkawa et al. [4]. In order to make clear the other toroidal flow generating mechanism the net toroidal drift motion of trapped tail ions is investigated and the averaged velocity of minority ions is estimated. A relatively good agreement is obtained between the simulation and estimated results. This indicates that the $k_{//}$ sign independent toroidal flow, that is dominant in the obtained result, is generated by the net toroidal motion of energetic tail ions.

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