Effect of Energetic Beam Ions on Radial Electric Field Transition in Helical Plasmas

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Radial electric field plays an important role in the neoclassical and anomalous transport in helical plasmas. A steep electron temperature gradient has been obtained near the central region in LHD, CHS, W7-AS, TJ-II with a strong central ECH[1], where strong positive radial electric fields have been observed related to the electron-root of neoclassical transport theory. However, no clear increase of ion temperature was obtained and this indicates that the electron-root confinement improvement with $T_e >> T_i$ is not suitable for a future helical reactor.

Recently, a rapid increase of ion temperature has been observed in LHD high-Z plasma[2] and this would also be related to the electron-root transition. But, in these plasma, the strong tangentially injection NBI heating is applied to a low density plasma ($\sim 0.5 \times 10^{19} cm^{-3}$) and beam ion density becomes comparable to the background electron density. Therefore a consistent analysis including the bean ion distribution is necessary to determine the radial electric field.

In this paper we study the effect of tangentially injected beam ions on the radial electric field transition in LHD plasma. The beam ion transport is analyzed by GNET/FIT[3] and the neoclassical transport is by DCOM/NNW[4]. It is found that the radial transport of tangentially injected beam ions during slowing-down is very small compared to that of thermal ions and the net ion particle flux is reduced effectively by the existence of the slowing-down beam ions. Also we found that this reduction of net ion particle flux can enhance the transition of the radial electric field to the electron root in LHD.

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