Role of negative potential barrier formed by electrons confined in stochastic magnetic region of helical nonneutral plasmas

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Research on nonneutral plasmas confined on toroidal magnetic surfaces has been intensively conducted in recent years [1, 2]. Despite the closed magnetic surfaces, no break-up of those is required when the plasmas are produced. In experiments on both Compact Helical System (CHS) and Heliotron J, an electron-gun (hereafter, e-gun) has been installed in the stochastic (or ergodic) magnetic region (SMR) surrounding the last closed flux surface (LCFS) and just ejected thermal electrons in the SMR. Then, within the order of 10 μs after the injection, those have penetrated deeply in the helical magnetic surfaces (HMS), spread rapidly in the whole of the closed surfaces, and finally formed a helical nonneutral plasma there.

In this work, we numerically find the inward propagation of a single electron injected into the SMR where negative ϕ_s is extended. The physical mechanism can be explained as follows; in the SMR, the pitch angle of the injected electron is changed considerably during it circulates in the SMR. Due to the pitch angle scattering, the particle sometimes turns to be a helically trapped particle in the upper side region of the HMS and starts a downward movement along one of the $|B_{min}|$ contours, that is, an inward drift motion across the HMS. Actually, considerable propagation across the HMS has been observed for several cases. Once penetrating deeply, the electron can never escape from the last closed flux surface because the negative potential formed by electrons confined in the SMR acts as a negative potential barrier. This seems to be the reason why nonneutral plasmas can be successfully produced inside the LCFS, in spite of the electron injection from the outside there. The detail of the mechanism will be presented in this conference.

[1] H. Himura *et al.*, Phys. Plasmas **14** (2007) 022507.
[2] M. Hahm *et al.*, Phys. Plasmas **15** (2008) 020701.