First Result of Nonneutral Plasmas Confined on Helical Magnetic Surfaces of Heliotron J

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Research on physics of nonneutral plasmas confined on helical magnetic surfaces (HMS) has intensively proceeded in the last decade. The first series of the experiment of helical nonneutral plasmas had been carried out on the Compact Helical System (CHS), where a couple of significant phenomena were clearly observed; (1) noneutral plasmas were successfully produced on the HMS without breaking them up, and (2) equipotential surfaces of the nonneutral plasmas deviates about several centimeters from the HMS.

In order to investigate the details of those, we have recently resumed the experiments on the Heliotron J machine in which the HMS can completely detach from the vacuum vessel as well. In fact, on the machine, a systematic test for our recent theory on the formation process of the helical nonneutral plasmas could be performed. In addition, a longer confinement may be attained on the HMS of Heliotron J, because the device is one of quasi-advanced sterallators. Figure 1 shows a set of preliminary results of measured radial profiles of self space potential ϕ_s, electron density n_e, and electron temperature T_e of helical nonneutral plasmas produced on Heliotron J. The method of injecting electron through the stochastic magnetic region is applied to the experiments. As clearly recognized, considerable values of ϕ_s are formed on the HMS, which shows that helical nonneutral plasmas are successfully produced on the HMS. Also, apparent difference between the two values of ϕ_s measured on every magnetic surface is appeared, which strongly suggests that the equipotential surfaces shifts from the HMS. Such a difference can be also recognized in the measured n_e, while only a little difference in T_e is observed. Since the parallel electrostatic force in nonneutral plasmas is hardly small compared to the pressure gradient force along magnetic field lines, the simultaneous equations of Boltzman's and Poisson's one describe the equilibrium state of nonneutral plasmas confined on closed magnetic surfaces. According to the theory, the variation of ϕ_s along a line of force on an outer HMS near the last closed flux surface is estimated 70 V for the case of $\Delta|\vec{B}| = 45$ G, and the corresponding n_e-variation on the same field line would be in the range between 5.0 and 15×10^9 m^{-3}. The experimental data will be measured in the next series of experiments.

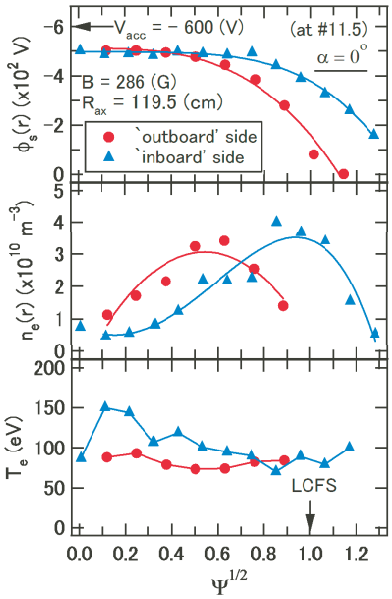

Figure 1: Radial profiles of ϕ_s, n_e, and T_e of nonneutral plasmas confined on Heliotron J.