Experimental studies on helical nonneutral plasmas with helical magnetic axis

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Recently, experimental studies on toroidal nonneutral plasmas confined on helical magnetic surfaces (HMS) have newly conducted. From the physical point of view, the observed phenomena in helical *nonneutral* plasmas are quite unique that have never seen in helical *neutral* plasmas. In nonneutral plasma experiments on Compact Helical System (CHS), it was clearly observed that the injected electrons could penetrate quickly into the HMS from the outside of the last closed flux surface (LCFS) [1]. To explain the rapid penetration, a numerical work has been performed using an orbital calculation code that takes into account two experimental findings [2]. One of those is that the plasma equipotential surfaces are not corresponded with the HMS. The finding has also been recognized along the magnetic axis of the HMS in the another experiment [3], where the obtained data has been compared with the result from an MHD equilibrium code.

However, the study [3] was conducted only along the magnetic axis. No data have been outputted along a magnetic field line. Moreover, both the past studies [2, 3] were performed on the HMS with a plane magnetic axis. No experiment has been done in a device having a helical magnetic axis yet. In order to examine the physics systematically, we have started new experiments of helical nonneutral plasmas on Heliotron J, one of medium-size machines with helical magnetic axis [4]. Two different methods of producing helical nonneutral plasmas developed in past studies [2, 3] are applied to the Heliotron J experiments. The plasma parameters of the space potential ϕ_s, the electron density n_e and the electron temperature T_e are measured by the probing employed [1]. The first data clearly show the variations of ϕ_s along the helical magnetic axis. Also, it is found that both $n_e(r)$ and $\phi_s(r)$ depend on the method of plasma production, which has not been examined in the past experiments. In fact, when electrons are injected from the LCFS, $n_e(r)$ shows a hollow distribution, while a bell distribution for the case where thermionic electrons are supplied from the center of the HMS. In the conference, the result of the first experiment and related analyses will be addressed.

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