In-surface electrostatic potential variations in the TJ-II stellarator


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In the last years experimental reports of asymmetries in the impurity density and parallel flow have fostered [1, 2, 3], highlighting the possible implications for the radial transport of impurities. The non-constant part of the electrostatic potential \( \phi_1 \) can become an important term in the parallel force balance and cross-field velocities of impurities, as it causes electrostatic trapping and \( E \times B \) radial drifts. These effects, which are more important the higher the charge of the impurity species, can significantly affect the flux-surface averaged radial flux of impurities under realistic plasma condition [4]. However important, the experimental study of \( \phi_1 \) is a complicated task. On the one hand, two-point measurements of plasma potential on the same flux surface are not widely available in fusion devices. On the other, a precise positioning of the two measuring systems in the magnetic field structure is required to ensure that radial electrostatic potential variations are not misinterpreted as in-surface variations.

In this work we present and discuss the first observations of electrostatic potential variations within the flux surfaces of a toroidal magnetic confinement device [5]. Measurements are taken with two distant Langmuir probe arrays whose precise positioning is aided by the simultaneous detection of radially localized zonal-flow like structures. Significant differences between the floating potential at the two probe locations are observed in electron-root wave-heated plasmas, which are reduced in ion-root beam-heated conditions to eventually invert sign. The observations are compared with neoclassical Monte Carlo simulations of the first order correction of the ion distribution function with the EUTERPE code [4]. The order of magnitude and phase of the differences, as well as the observed dependencies on the electric field root, are reasonably well reproduced by the calculations.