Currents and electric fields in edge tokamak plasma

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Currents structure in the scrape-off layer (SOL) of a tokamak is analyzed. It is demonstrated that poloidal currents measured in the experiments are a combination of several current types of different physical nature. Besides known Pfirsch-Schlueter (PS) currents and thermoelectric currents, so-called PCC (plate closing) currents flowing to/from the divertor plates are also analyzed. The latter close radial currents in the SOL and below/above the *X*-point in the SOL and private region (PR). In particular, current flowing to the outer plate in the private region, opposite to thermoelectric current is predicted for the standard single-null configuration and favorable direction of ∇B drift. In addition, a pair of currents to and away from the outer plate should flow. In the single-null configuration they are often masked by a larger thermoelectric current, however for the connected double null (CDN) case, where thermoelectric current is strongly reduced due to smaller temperature asymmetry, these currents dominate. The suggested physical model is supported by results of simulations performed with SOLPS-ITER transport code. Simulations were done for ASDEX-Upgrade (AUG), L and H-modes, single-null configurations, and for GLOBUS-M H-modes, both disconnected and connected double null configurations. Results of the simulations are compared with probe measurements for AUG and Globus-M tokamaks, and reasonable agreement has been found. The role of parallel currents in the formation of the potential maximum/minimum in the vicinity of *X*-point for strongly detached regimes is also analyzed
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