Currents in the scrape-off layer of a tokamak

V. Rozhansky¹, E. Kaveeva¹, I. Senichenkov¹, D. Sorokina¹, E. Vekshina¹, D. Coster², P. McCarthy³, N. Khromov⁴ and the ASDEX Upgrade team

¹ Peter the Great St. Petersburg Polytechnic University, Polytechnicheskaya 29, 195251 St. Petersburg, Russia
² Max-Planck Institut für Plasmaphysik, EURATOM Association, D-85748 Garching, Germany
³ University College Cork, Ireland
⁴ Ioffe Institute, Polytechnicheskaya 26, St. Petersburg, Russia

rozhansky@mail.ru

Current structure in the scrape-off layer (SOL) of a tokamak is analyzed. It is demonstrated that poloidal currents measured in the experiments are combination of several types of currents of different physical origin. It is demonstrated that besides known Pfirsch-Schlüeter (PS) currents and thermoelectric currents, there are so-called PCC (plate closing) currents flowing to/from the divertor plates. The latter closes radial currents in the SOL and below/above the X-point. 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 gradB 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 larger thermoelectric current, however for connected double null (CDN) case, where thermoelectric current is strongly reduced due to less 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, M2 H-modes, both single and double null configurations.

Results of the simulations are compared with probe measurements for AUG and Globus-M tokamaks, reasonable agreement has been found. The conclusion is made that PCC currents are obtained in the simulations and are observed in the experiments.