Recent analysis of experimental data from different tokamaks suggests that the plasma coming into the scrape-off layer (SOL) from the bulk recycles at the wall of the main chamber [1-3], rather than flowing into the divertor and recycling there as the conventional picture of edge plasma flows would suggest. It implies rather fast radial plasma transport in the SOL of main chamber. Moreover, it seems that to be compatible with experimental observations radial transport should be convective rather than diffusive [1].

One of the possible mechanisms of fast convective plasma transport in the SOL can be associated with plasma blobs [4] observed in experiments [5, 6]. These are coherent structures extended along the magnetic field lines with density of the order of the separatrix density, which is much higher than the ambient plasma density in the far SOL. The origin of these blobs in the SOL can be rather strong plasma turbulence in the separatrix region causing strong plasma stratification and detachment of plasma blobs from the bulk plasma.

**a) Analytic theory.** The $\nabla \times B$ drift of charged particles in a tokamak magnetic field results in plasma polarization and, correspondingly, $E \times B$ plasma flow. This effect of $E \times B$ flow becomes rather strong in the SOL due to the effective “sheath resistivity” [7] caused by plasma contact with the divertor target. However, unlike [7] we assume that the perpendicular scales of coherent structures (blobs) are much smaller than the minor radius. The radial velocity of these blobs can be estimated as follows [4, 8] $V_b \sim C_s \left( \frac{\rho_s}{\delta_b} \right)^2 \left( \frac{L}{R} \right) \sim 1000 \text{ m/s}$, where $\delta_b$ is the poloidal width of the blob. We notice that both the estimate of the blob velocity $V_b$ and flux and density profiles are in a reasonable agreement with recent experimental data [9].

**b) Modeling of the blobs with turbulence codes.** 2D modeling of the SOL plasma turbulence with the equations one fluid equation and their improved versions clearly shows strongly intermittent (bloppy) plasma transport with fast non-diffusive features somewhat similar to the experimental observations (e. g. [9]). We also perform and present the results of 3D SOL plasma turbulence modeling with the code BOUT [10]. We discuss the effects of blobby transport in the SOL on impurity penetration to the core plasmas.

**c) Macroscopic transport modeling of the edge plasma transport in tokamaks.** We incorporate into the 2D edge transport code UEDGE a cross-field plasma transport model which includes both diffusive and outward convective terms for the cross-field plasma particle flux. Poloidally-varying outward convective term, describing the effect of blobby anomalous transport at the outer side of the torus, was tested on DIII-D discharges. The results of the modeling confirm the crucial importance of convective transport for the edge plasma [1]. They clearly demonstrate that convective transport has a significant effect on the averaged plasma characteristics in both the main chamber and divertor.


* Work supported by U.S. DOE