2C01

# On non-diffusive plasma transport at tokamak edge*

A. Yu. Pigarov[1], G. Q. Yu[1], S. I. Krasheninnikov[1], D. A. D'Ippolito[2], J. R. Myra[2], D. R. McCarthy[3], T. D. Rognlien[4], J. A. Boedo[1], D. L. Rudakov[1], W. P. West[5], B.LaBombard[6], B. Lipschultz[6], R. Maingi[7], and V. Soukhanovsky[7]

[1]University of California San Diego; [2]Lodestar Research Corporation; [3]Southeastern Louisiana University; [4]Lawrence Livermore National Laboratory; [5]General Atomics, [6]Massachusetts Institute of Technology, [7]Princeton Plasma Physics Laboratory

**Abstract**

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], 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[2] observed in experiments[3]. The origin of these blobs in the SOL can be rather strong plasma turbulence in the separatrix region. The $\nabla B$ drift of charged particles in the SOL and the effective "sheath resistivity"[4] caused by plasma contact with the divertor target result in $\mathbf{E}\times\mathbf{B}$ plasma radial flow. Estimates[2] of radial velocity of the blobs with a scale length ~ 1cm give ~1000m/s which is in a reasonable agreement with recent experimental observations[5]. In this paper we present:

*a) 2D Modeling of blob/dip propagation*. 2D modeling of blob propagation with the one fluid equations clearly show that for the DIII-D plasma parameters blobs with radial scale length ~ 1cm can propagate radially as a coherent structure at a distance ~ 10 cm. Blobs with larger radial scale lengths are the subjects of flute instability causing "fingering" effects. Nevertheless, "fingers" continue to propagate radially on large distances. Blobs with smaller radial scale are strongly affected by vorticity effects but still propagate radially on large distances. (On stability of the blobs see also D. A. D'Ippolito et al. this meeting) We also present our results on the modeling of dip (holes in plasma density) propagation.

*b) 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 Alcator C-Mod, DIII-D, and NSTX discharges. The results of the modeling confirm the crucial importance of convective transport for the edge plasma. They clearly demonstrate that convective transport has a significant effect on the averaged plasma characteristics in both the main chamber and divertor.

[1] M. Umansky, et al., Phys. Plasma **5** (1998) 3373; R. Schneider et al, 17th IAEA, Japan, 19-24 October 1998; B. Lipschultz et al., 18th IAEA, Italy, 4-10 October 2000.

[2] S. I. Krasheninnikov, Phys. Letters A, **283** (2001) 368; D. A. D'Ippolito, J. R. Myra, and S. I. Krasheninnikov, Physics of Plasmas **9** (2002) 222.

[3] S. J. Zweben Phys. Fluids **28** (1985) 974; M.V. Heller, et al., Phys. Plasmas **6** (1999) 846; J. L. Terry, R. Maqueda, C. S. Pitcher et al., J. Nuclear Material, **290-293** (2001) 757.

[4] A. V. Nedospasov, V. G. Petrov, and G. N. Fidel'man, Nuclear Fusion **25** (1985) 21.

[5] J. A. Boedo, D. L. Rudakov, R. Moyer *et al*., Phys. Plasmas **8** (2001) 4826; S. J. Zweben, D. P. Stotler, J. L. Terry et al., Phys. Plasmas **9** (2002) 1981

---

* Work supported by U.S. DOE