Evaluation of the turbulent particle flux by Heavy Ion Beam Probe in the T-10 tokamak

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The direct measurements of the turbulent particle flux at the plasma edge may be performed by multipin Langmuir probes, while in the core plasmas it presents a challenging task due to the necessity to measure simultaneously the plasma density and radial velocity oscillations. Multichannel Heavy Ion Beam Probe (HIBP) is capable to provide such measurements. The report presents new findings in the behavior of geodesic acoustic modes (GAMs) and broadband oscillations (<250 kHz) of the plasma electric potential and density in Ohmic and ECRH regimes of T-10 ($B_t = 1.6-2.4$ T, $I_p = 0.15-0.3$ MA, $\bar{n}_e = 0.6-3.5\times10^{19}$ m$^{-3}$) as measured by HIBP in the core plasmas. The multichannel HIBP measures oscillating component of the electric potential $\phi_k$ and density $n_k$ in each of 3 points separated poloidally at the distance $\Delta x_k$, $k = 1, 2, 3$ is a number of points. Thus, the oscillating poloidal electric field $E_{pol} = (\phi_k - \phi_{k+1})/\Delta x_k$ and the radial $E\times B$ velocity $V_t = E_{pol} / B_t$ may be determined. Finally, the electrostatic turbulent radial particle flux driven by $E\times B$ drift, $\Gamma = <n > V_t$ was found.

The frequency resolved particle flux shows that the main contribution to the total flux is given by the quasicoherent mode with frequency 70-120 kHz. The preliminary experiment shows that in contrast to the power spectral density of plasma potentials $\phi_k$, GAM peak was almost invisible in the $E_{pol}$ power spectrum and on the frequency resolved turbulent particle flux. These results are consistent with the general concept of GAM as a high-frequency branch of zonal flows, having symmetric poloidal structure of potential perturbation, which were supported by earlier T-10 observation of poloidal mode number $m = 0$. The estimates show that the turbulent flux presents a significant fraction of the total particle flux.

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