

Investigation of the statistical properties of electric potential oscillations in the T-10 tokamak

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Highlights in fusion plasma performance have been obtained under conditions where ExB shear stabilization mechanisms are likely to play a key role; both edge and core transport barriers are related to a large increase in the ExB sheared flow. The oscillating shear flows, zonal flows and Geodesic acoustic modes (GAMs) are widely considered now as a turbulence stabilization mechanism. The study of the properties of plasma electric potential oscillations may explain the turbulence-zonal flow interplay [1, 2, 3].

Low frequency ($f < 50$ kHz) electric potential oscillations were investigated on the T-10 tokamak using Heavy Ion Beam Probe (HIBP), Correlation Reflectometry (CR) and Langmuir probes (LP). Regimes with Ohmic heating and with on- and off-axis ECRH were studied ($B = 2.2\text{--}2.5\text{ T}$, $I_p = 180\text{--}330\text{ kA}$, $n_e = 1.3\text{--}2.5 \times 10^{19}\text{ m}^{-3}$).

It was shown that GAMs might have a complex structure, not similar to conventional periodical oscillations with a single frequency. GAMs have an intermittent character presenting the stochastic sequence of the wave packages with a "lifetime" in a range of 0.5 - 2 ms. GAMs are more pronounced in ECRH plasmas [1, 4]. At the outer one third of the plasma column GAMs may be characterized not only by single but also by a couple of closed but separated frequencies in a narrow interval 22-27 kHz. Each frequency peak is characterized by high potential/density correlation ($\text{coh} > 0.6$) and constant cross-phase, $\theta = -\pi/2$ for the main GAM peak, similar to [5], and $\theta = +\pi/2$ for the satellite. The low frequency MHD mode $m=3$ is pronounced at 7 kHz.

The long-term correlation between potential (HIBP) and density (CR) oscillations was studied whereby the CR antenna was shifted toroidally by one quarter of the torus similar to the duo-HIBP experiments in CHS [3]. The result of the correlation measurements of the two diagnostics shows the high coherency ($\text{coh} > 0.4$) for GAMs and low frequency MHD modes, suggesting the global character of the modes.

The MHD mode $m=3$ is also pronounced in core plasma potential and density (HIBP) and in floating potential at the plasma edge (LP) by quasicohherent oscillations with $f = 7$ kHz with high coherency between plasma potential (HIBP) and floating potential (LP). It also exhibits the stochastic character with $\sim 1\text{--}2$ ms time-scale. Sawtooth oscillations presents the common mechanism modulating potential oscillations for both GAM and MHD mode $m=3$.

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