External Modification of Intermittent Burst Temporal Characteristics at the Edge of the CASTOR Tokamak

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Plasma turbulent transport at the edge of tokamaks is the object of one of the most intense studies in modern magnetic fusion research. Nowadays it is widely accepted that edge plasma transport has strong convective character. Large scale turbulent events – density bursts, which are formed intermittently on the diffusive background, play the important role in edge transport. These bursts cause rapid convective radial transport of plasma towards the wall with a speed which is a fraction of the ion sound speed. The most important result of this is that core plasma confinement degrades. At the same time in large scale tokamaks, especially in next generation devices like ITER, density bursts can cause the strong erosion of the first wall and unwanted retention of tritium. Therefore, it is very important to understand the physical nature of edge plasma turbulent transport – especially the origin and dynamics of density bursts – and develop the methods for their external modification and control.

Recently it has been shown that study of the intermittent burst temporal characteristics is an effective way for the understanding the plasma turbulent transport at the edge of tokamaks [1-3]. As for the methods for the external modification of intermittent density bursts in the CASTOR tokamak, we have used the plasma polarization (biasing). In particular, the graphite electrode has been inserted into plasma and biased with respect to the vacuum chamber wall. We used Langmuir probes for the detection of density bursts and measurements of their temporal characteristics such as average burst rate and average burst duration.

Plasma polarization – biasing at the edge of the CASTOR tokamak significantly modifies the burst temporal characteristics compared to the Ohmic discharge conditions. In particular, average burst rate increases and average burst duration decreases compared to the same characteristics in Ohmic regime. The reason of this is that biasing imposes strong shared poloidal rotation on plasma, splits large coherent structures which we had in Ohmic phase into smaller ones and rapidly moves them poloidally. As a result during biasing the Langmuir probe detects larger number of bursts than in Ohmic phase and average burst rate increases. As for the decrease of average burst duration during biasing the reason of this is that during biasing we have smaller structures which move faster than in Ohmic phase, therefore they need less time to cross the probe pins and average burst duration decreases. We also observe the increase of average plasma density during biasing. The reason of this is that biasing splits coherent structures and reduces the radial transport thereby improving confinement. Thus, biasing is an effective mechanism for the improvement of plasma confinement in tokamaks.

References

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