Study of the ELM-free regimes by Doppler backscattering in the Globus-M tokamak

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Doppler backscattering (DBS) diagnostics was recently implemented to study plasma rotation velocity and plasma density fluctuations in regimes with improved confinement characterized by the absence of edge localized modes (ELMs). DBS operated in the 20-48 GHz band at O-mode propagation so that the detection region covered a considerable radial interval of normalized minor radii ρ = 0.6 - 1 for typical Globus-M discharges [1]. Two events were investigated: the transition from ELM to ELM-free H-mode and I-phase. These two phenomena are united by the appearance of quasi-coherent (QC) modes. QC modes have been observed through a spectral analysis of plasma density fluctuations derived from the DBS diagnostics. The transition from ELM to ELM-free H-mode is characterized by a decrease in Dα emission and a simultaneous increase in plasma density, which indicates an improvement in confinement. According to the multi-frequency DBS data suppression of peripheral broadband fluctuations was observed at ρ = 0.7 – 0.9 in the ELM-free stage. At the same time quasi-coherent modes appeared and increased with a frequency of $f_{QC} \approx 100$ kHz in the frequency band near $\Delta f_{QC} \approx 50$ kHz in the inner region ρ = 0.6. Another type of QC-mode has been investigated in the I-phase. I-phase is characterized by limit-cycle oscillations (LCO). LCO were found as low-frequency (5-9 kHz) oscillations in D_α light emission, turbulence amplitude, E×B velocity, mean plasma density and magnetic field [2]. The frequency of QC-mode in the I-phase was found $f_{QC} = 110$ kHz with a spectrum width $\Delta f_{QC} = 80$ kHz. The experiments have shown that the QC modes are localized in the ρ = 0.6 – 0.7 region. It was found that the QC mode amplitude is modulated by LCO. The phase relationships between the amplitude of QC modes and LCO were investigated in detail. The bicoherent analysis demonstrates the presence of nonlinear coupling of QC modes to the broadband turbulence. The research was financially supported by RSF (project № 18-72-10028).

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