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Fusion Research in Ioffe Institute

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Overview of activity of the Plasma Physics Division at the Ioffe Institute in support of fusion program is presented. Experiments on LHCD (100kW, 2.5GHz) at the Globus-M tokamak (R=0.36m, a=0.24m, B_tor=0.4T, I_pl=200kA) with poloidally oriented grill resulted in RF driven current of up to 40 kA, in agreement with the theory predictions. At the FT-2 tokamak (R=0.56m, a=0.08m, B_tor=2.3T, I_pl=30kA) experiments with traditional toroidally oriented grill revealed no dependence of LHCD density limit on H/D ratio in spite of 3 times different LH resonance densities. Microwave Doppler Reflectometry (DR) at the Globus-M, and DR and Heavy Ion Beam Probe measurements at the tokamak TUMAN-3M (R=0.53m, a=0.24m, B_tor=1.0T, I_pl=190kA) demonstrated GAM suppression at the L-H transition. Observations at the FT-2 using Doppler Enhanced Scattering showed that GAM amplitude is anti-correlated both spatially and temporally with electron thermal diffusivity. For the first time turbulence amplitude modulation at GAM frequency was found both experimentally and in global gyrokinetic modeling. A model of L-H transition is proposed based on this effect. The loss mechanisms of energetic ions'(EI) were investigated in the NBI experiments on Globus-M and TUMAN-3M: orbit losses, sawtooth triggered redistribution of EIs and Alfvenic mode excitation. Non-conservation of adiabatic invariant of EI in small aspect ratio configuration was found numerically to play a role in EI losses. Empirical scaling of 2.5 MeV DD neutron rate for the two devices shows strong dependence on toroidal field (B_tor)^1.29 and plasma current (I_pl)^1.34; this justifies B_tor and I_pl increase by a factor of 2.5 in proposed upgrade of Globus-M. Bursts of ~1MHz Alfvenic type oscillations correlating with sawtooth crashes were observed in OH at the TUMAN-3M. Possibility of low threshold parametric excitation of Bernstein and upper hybrid waves trapped in drift-wave eddies resulting in anomalous absorption in ECRH experiments in toroidal plasmas was discovered theoretically. A novel method of radial correlation Doppler reflectometry is shown to be capable of measuring the turbulence wave-number spectrum in realistic 2D geometry. Progress in design and fabrication of three diagnostics for ITER developed in Ioffe institute is reported: Neutral Particle Analysis, Divertor Thomson Scattering and Gamma Spectroscopy.

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