Efficiency of the X-mode anomalous absorption in the plasma filament associated with the two upper-hybrid-plasmon decay

A. Altukhov[b], V. Arkhipenko[a], A. Gurchenko[b], E. Gusakov[b],
A. Popov[b], L. Simonchik[a], P. Tretinnikov [b], M. Usachonak[a]
[a] *Stepanov Institute of Physics of NAS of Belarus, Minsk, Belarus*
[b] *Ioffe Institute, St-Petersburg, Russia*

As it was shown firstly at the Textor tokamak [1], the second harmonic X-mode heating experiments are accompanied by anomalous backscattering phenomena. The theoretical model proposed recently [2] explains the anomalous backscattering as a result of the two upper-hybrid (UH) plasmon parametric decay (TUHPD) instability possessing very low threshold due to trapping of nonlinearly excited plasmons in the vicinity of the density maximum that accompanies the magnetic island. The theory [2] also predicts substantial (up to 25%) anomalous absorption due to this process.

To test an efficiency of the X-mode anomalous absorption associated with the TUHPD leading to excitation of the trapped UH waves the model experiment is performed in the laboratory plasma. The TUHPD occurs in a plasma filament produced by high-frequency discharge (27 MHz, 100 W) in long quartz tube with the inner diameter of 22 mm filled with argon (pressure about 1 Pa) oriented in the direction of the magnetic field. The tube passes through the waveguide (72 x 34 mm^2) in parallel to the wide wall. Using the waveguide the X-mode microwave pulses (up to 200 W) at frequency of 2.35 GHz, substantially higher than the electron cyclotron resonance and UH values, are incident onto the plasma. By means of optical and microwave diagnostics the strong anomalous absorption of the microwave power is observed in the plasma at density higher than the UH resonance value for the frequency equal to half value of the pump frequency. The microwave power (incident, reflected, transmitted) is measured and efficiency of anomalous absorption due to the TUHPD is determined at the level of 80% in maximum and 45% in the steady state.

The theoretical model of the two-UH-plasmon decay in strongly inhomogeneous plasma is developed demonstrating a huge growth of nonlinear coupling in this case. The localization, threshold and growth rate of the TUHPD instability is determined in agreement with experimental observations.

Financial support of the RSF grant 16-12-10043 and BRFBR grant BRFBR F16R-095 is acknowledged.

[1] S.K. Nielsen, M. Salewski, et al., Plasma Phys. Control. Fusion 55, 115003 (2013)
[2] E.Z. Gusakov and A.Yu. Popov, Physics of Plasmas 23, 082503 (2016)