Experimental modelling of decay instability of the extraordinary polarization wave on two upper hybrid plasmons in the plasma filament

Arkhipenko V.I., Simonchik L.V., Usachonak M.S., 1Altukhov A.B., 1Gurchenko A.D., and 1Gusakov E.Z.

Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Belarus Ioffe 1Physical Technical Institute, Russian Academy of Sciences, Saint Petersburg, Russia

In the recent decade, there has been accumulated a large number of observations in the ECR plasma heating experiments in tokamaks and stellarators that do not fit into a simple linear picture [1]. Among these phenomena it was studied in detail the anomalous backscattering of heating microwave radiation with a frequency shift that was observed in the heating experiments on the second harmonic resonance in Textor tokamak [2]. In these experiments it was shown that the radiation temperature of scattered radiation is thousand times greater than the electron temperature, and its amplitude is modulated at a frequency of magnetic island. At that, the highest level of anomalous scattering is achieved when plasma density in the island coincides with the upper hybrid density for frequency equalling to the half value of the pump frequency. This made it possible to propose a theoretical model [3] allowing us to explain the effect of anomalous backscattering as a result of excitation of parametric instability (PI) of the pump wave decay into two upper hybrid (UH) plasmons trapped in the vicinity of the maximum density that accompanies the island [4].

In this paper, an attempt is made to experimentally model low-threshold PI of two-plasmon decay. This decay occurs in a plasma filament extended in the direction of the magnetic field and is produced with a high-frequency discharge. The plasma volume (quartz tube with an inner diameter of 22 mm) filled with argon (at a pressure of about 1 Pa) passes through the waveguide (72 × 34 mm2) in parallel to the wide walls. Initial plasma is created by high frequency power of about 100 W at frequency of 27 MHz. The power is supplied to the ring electrodes placed outside of the quartz tube which are disposed on both sides of the waveguide at a distance of about 30 cm. When using waveguide the microwave power pulses (up to 200 W) at frequency of 2.35 GHz are incident to the plasma. The microwave has an extraordinary polarization and its frequency is much higher than the EC and UH values. The presence of strong anomalous absorption of microwave power in the plasma where its density is higher than the value for the UH resonance for the frequency equal to half value of the pump wave frequency is demonstrated by means of optical and microwave diagnostics. This effect and its dependence on magnetic field, plasma density and microwave power has been investigated. The thresholds of anomalous absorption are determined. Experiments on plasma diagnostics by probing microwave with a frequency close to the resonance frequency of the second harmonic are fulfilled.

The work was performed at the support of grants RFFR Bel-a 16-52-00019 and BRFBR F16R-095.

References

1. M. Porkolab, B.I. Cohen 1988 Nucl. Fusion 28, 239
2. S.K. Nielsen, M. Salewski, E. Westerhof et al. Plasma Phys. Control. Fusion 55, 115003 (2013)
3. E.Z. Gusakov and A.Yu. Popov 2016 Physics of Plasmas 23, 082503
4. M.Yu. Kantor et al. Plasma Phys. Control. Fusion 51, 055002 (2009)