anomalous absorption of the ordinary wave in the plasma filament

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Over the last decade, experiments on electron-cyclotron resonant heating (ECRH) have accumulated a large number of observations of various anomalous effects (anomalous backscattering, anomalously accelerated ions) [1–3], which are not explained within the conventional paradigm based upon the linear theory of wave propagation and absorption in plasma. A theoretical model proposed in [4] explains the anomalous backscattering of heating power in experiments on ECRH by an extraordinary wave at the second harmonic of a resonance, as an indirect manifestation of the parametric decay instability into two upper-hybrid plasmons, and this instability has a very low threshold due to nonlinear excitation of plasmons, which are trapped in the vicinity of the electron density maximum. In [5] we carried out model experiments to study the two-plasmons decay of an extraordinary wave, and it was shown that the anomalous absorption can reach 80%. A similar situation with the excitation of low-threshold instabilities may also appear for waves with ordinary polarization [6].

In this work, the anomalous absorption of an ordinary wave in a plasma filament created by RF discharge is under investigation. A plasma filament was formed in a quartz tube (inner diameter 22 mm) filled with argon at a pressure of about 1–2 Pa, placed on the axis of an electromagnet, which created a magnetic field of up to 45 mT. The tube passes through a microwave waveguide with a cross section of 72 × 34 mm2 perpendicular to waveguides wide walls. RF power (~100 W, frequency ~27 MHz) was supplied to the ring electrodes located outside of the tube at a distance of about 30 cm on both sides of the waveguide. The average plasma density is about 1.5 × 1010 cm–3 with a magnetic field of 45 mT and maximum RF power. Pulses of microwave power (up to 200 W) at a frequency of 2.35 GHz were supplied to the plasma by the waveguide. The frequency of microwave radiation, which is ordinary polarized in plasma, significantly exceeds the electron-cyclotron and upper hybrid frequency values. The presence effect of a strong anomalous absorption of microwave power in a plasma has been demonstrated using optical and microwave diagnostics. This effect, which has a threshold nature, was investigated depending on the magnetic field, plasma density, and microwave power. An experimental estimation of the absorption threshold gives an incident power level of about 30 W. Plasma luminosity radial profile changing was demonstrated during the microwave pulse. The absorption efficiency was about 30–35%. Experiments on the measurement of plasma microwave irradiation at a frequency close to half the pump frequency were carried out. The obtained effect was explained by the excitation of a parametric instability of the pump decay into two oblique Langmuir plasmons with close frequencies.

The work was performed under support of the RFFR under grant Bel\_a 18-52-00010 and BRFBR under grant F18R-040.

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