In a weaker field, the intensity of the exciton-magnon absorption should decrease gradually with increasing intensity of the external magnetic field, as is indeed observed in experiment.

In conclusion we note that the exciton-magnon mechanism is the main mechanism of absorption in antiferromagnetic crystals. Thus, the observed effect of attenuation of the absorption of light in a strong magnetic field has a general character for antiferromagnets. A similar behavior should obviously be observed also for all other "double" transitions (two-magnon or two-exciton) in an antiferromagnet.

A weakening of light absorption by means of a magnetic field was observed by us also in antiferromagnetic CoF_2.

We take the opportunity to thank E.I. Rashba for interest in the work.

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EXCITATION OF ION-ACOUSTIC WAVES BY LANGMUIR WAVES AND STATIONARY REGIMES IN A BEAM-PLASMA SYSTEM

A. S. Bakai, E. A. Kornilov, and S. M. Krivoruchko
Physico-technical Institute, Ukrainian Academy of Sciences
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We investigated the threshold excitation of ion-acoustic waves by Langmuir waves and the behavior of the amplitudes of these waves beyond threshold in a beam-plasma system.

As is well known, the electronic and ionic plasma oscillations interact effectively with each other and this interaction gives rise to a number of nonlinear phenomena, viz., energy exchange between waves [1, 2], control of the oscillation spectra with the aid of external modulation [3], threshold excitation of ion-acoustic waves by Langmuir waves [4], and others. The gist of the last of these phenomena is that in the presence of an intense Langmuir wave (frequency ω_0, initial amplitude a_0) an initially small amplitude of an ion-acoustic wave of frequency Ω and the amplitudes $a_{\pm n}$ of the Langmuir waves with combined frequencies $\omega_0 \pm n\Omega$ increase exponentially in time if a_0 exceeds a certain critical (threshold) value that depends on the values of the wave interaction and damping coefficients. The exponential growth of the initially small amplitudes takes place only during the initial state. In the course of time, a stationary regime is establish and constitutes an assembly of oscillations having the aforementioned frequencies and constant amplitudes. Naturally, a regime with nonzero stationary amplitudes is realized only if there exist forces (such as an external field or a beam) that compensate for the energy dissipation in the system of interacting waves.

The interaction between the electronic and ionic oscillations should become manifest effectively and play an important role in the beam-plasma system under conditions when the beam excites intense electronic oscillations. The excitation of ionic excitations by electronic ones leads to an effective heating of not only the electrons but also the ions, and exerts a noticeable influence on the character of the process of excitation of the oscillations by the beam.

The purpose of the work was twofold: 1) to investigate the interaction of Langmuir and ion-acoustic oscillations in a beam-plasma system, and 2) to study the near-threshold stationary regimes in the system of interacting waves. This makes it possible to study the dynamics of wave interaction in the beam-plasma system and to ascertain the possibility of two-stream heating of a plasma.

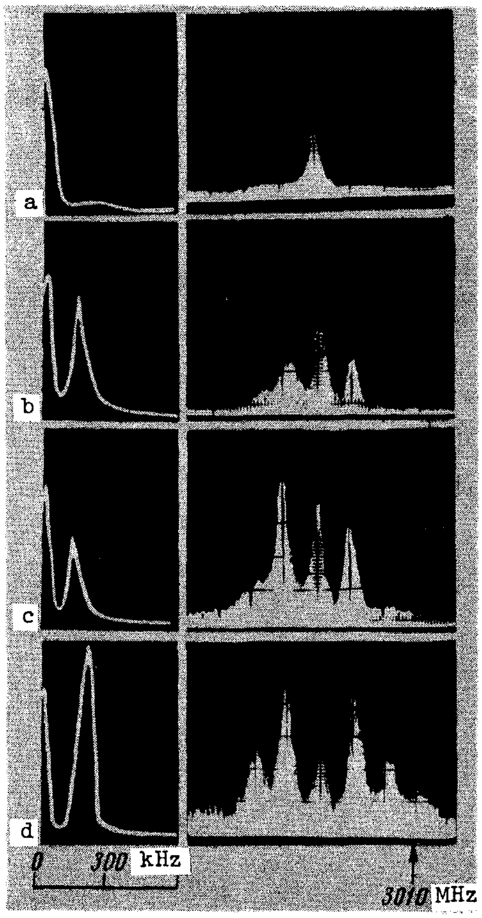

Fig. 1

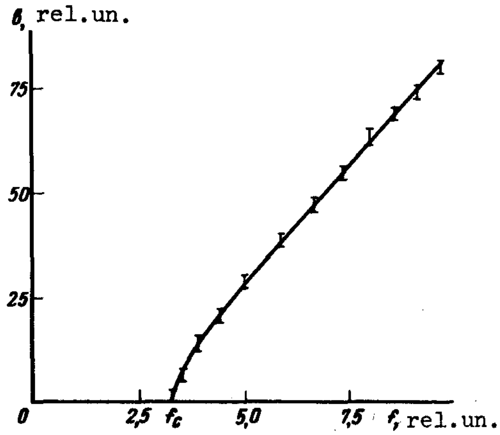

Fig. 2

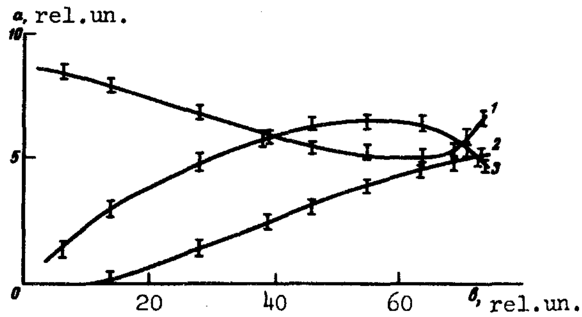

Fig. 3

Fig. 1. Spectra of Langmuir and ion-acoustic oscillations at different external-signal amplitudes: a) $f < f_c$, b - d) $f > f_c$.

Fig. 2. Dependence of the amplitude of the ion-acoustic oscillations on the external-signal amplitude.

Fig. 3. Experimental plots of the amplitudes a_1, a_2, and a_3 on the amplitude of the ion-acoustic oscillations.

The experiment was performed with the setup described in [3]. The main parameters of the experiments were: plasma density $\sim 10^{11}$ cm^{-3}, beam current $\sim$100 mA, energy 5 keV, intensity of constant homogeneous longitudinal magnetic field 1 kG.

The experiment was performed under conditions of amplification of the high-frequency signal from an external generator at a frequency ω_0 close to the electron plasma frequency ω_p. At small external-signal amplitudes f, the amplitude a_0 of the wave in the plasma with frequency ω_0 increases in proportion to f up to a certain critical value, after which ion-acoustic and combined waves are excited. Figure 1 shows a series of oscillograms photographed from the screens of spectrum analyzers, illustrating the process of excitation of the ion-acoustic waves by the Langmuir waves.

According to the predictions of the theory developed by one of the authors in [5], we have for the stationary amplitude of the ion-acoustic waves beyond threshold

$$b \sim \sqrt{f/f_c - 1} \quad \text{for} \quad (f - f_c)/f_c \ll 1,$$

where f_c is the threshold value of the amplitude of the external signal. When $f/f_c \gtrsim 1$, the amplitude b increases linearly with f. It is seen from Fig. 2 that these conclusions are in good agreement with experiment.

The expressions for the amplitudes of the Langmuir oscillations near threshold can be represented in the form of an expansion in powers of the amplitude b. Accurate to quadratic terms, we have

$$a_0 \sim 1 - c_0 b^2, \quad a_\pm \sim c_{\pm 1} b, \quad a_{\pm 2} \sim c_{\pm 2} b^2,$$

where c_0, $c_{\pm 1}$, and $c_{\pm 2}$ are certain constants that depend on the dynamic parameters, viz., the interaction coefficients, the wave damping, and the detuning. These relations between the amplitudes have been observed experimentally (Fig. 3).

The increase of the external-signal amplitude f beyond threshold leads to excitation of "relaxation" oscillations similar to those described in [6]. These oscillations are characterized by intense diffusion of the plasma to the walls of the tube and by appreciable oscillations of the plasma density and temperature.

Our investigations show that ion-acoustic oscillations are excited in a beam-plasma system starting with a certain threshold value of the Langmuir-oscillation amplitude.

The power of the ion-acoustic oscillations beyond threshold is proportional to the power P of the external high-frequency signal.

The power of the Langmuir oscillations beyond threshold increases like $\sqrt{P}$.

The growth of the ion-acoustic or Langmuir oscillation amplitudes is limited by the excitation of relaxation oscillations.

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EXPERIMENTAL INVESTIGATION OF INDUCED SCATTERING OF PLASMA OSCILLATIONS IN A STRONG MAGNETIC FIELD

A. N. Izmailov, B. I. Ivanov, L. A. Mitin, V. D. Shapiro, and V. I. Shevchenko
Physico-technical Institute, Ukrainian Academy of Sciences
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It is known that induced scattering leads to instability of a monochromatic wave of frequency ω_{k_0} and wave vector $\vec{k}_0$ against excitation of long-wave oscillations $(\omega_k, \vec{k}, k < k_0)$ [1]. The purpose of the present study was to investigate experimentally this instability in a plasma placed in a strong magnetic field. The experiments were performed with a one-sided Q-machine placed in a homogeneous magnetic field of intensity $H = 2\times10^3$ Oe. The system was evacuated to a pressure $(0.5 - 1)\times10^{-6}$ Torr and filled with a helium plasma of density $(1 - 2)\times10^9$ cm^{-3}. The plasma-to-cyclotron frequency ratio under the conditions of the experiment, ω_p/ω_H, was equal to 1/10 - 1/15. The electron thermal velocities ranged from 3×10^7 to 4×10^7 cm/sec.

The plasma oscillations were excited with the aid of a system of coaxial probes, and a movable coaxial probe was used to extract the oscillations. A study of the dispersion law of these oscillations has shown that the first radial harmonic of the Langmuir oscillations of the magnetized plasma is excited in the system: