voltage. A distribution of the type P-2 was observed by us also in illuminated samples of n-Ge with antibarrier contacts. In p-Ge samples with barrier contacts we observed a distribution of the type P-3, which is evidence of enrichment of the near-contact regions with carriers, and a current pulse that increases with time.

The nature of these described phenomena is apparently connected with complex manifestations of exclusions under conditions of a strong high-frequency field and are presently under study.

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EXPERIMENTAL INVESTIGATION OF THE NONLINEAR STAGES OF DEVELOPMENT OF ION-ACOUSTIC INSTABILITY IN A PLASMA-BEAM DISCHARGE

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As is well known, low-frequency (LF) instabilities play a decisive role in processes of anomalous diffusion, heating, and acceleration of ions due to collective interactions in a plasma.

The linear stage of development of LF instabilities was investigated in sufficient detail theoretically and experimentally [1 - 3]. The investigation of the nonlinear stage has barely begun. The main characteristics of the nonlinear turbulent stage of development of the instability, as is well known, are the spectral density of the energy of the excited electric fields, the space-time correlation functions, the presence of phase jumps, and the dispersion relation. All these are being experimentally investigated at the present time with the aid of methods described in [4 - 7].

The experiments were performed with a setup described in detail in [4]. The main parameters were: electron-beam current 5 A, energy 10 - 12 keV, current pulse duration 100 μsec, density of plasma produced by the beam 5×10^{12} - 2×10^{13} cm^{-3}, intensity of longitudinal magnetic field up to 2 kOe, working gas - hydrogen.

We have investigated the LF oscillations excited upon interaction of an electron beam with a highly-ionized plasma. The shape of these oscillations was investigated with the aid of probes placed along the interaction region (inside the plasma chamber) and registering the E_z component of the electric field in the frequency range up to 8 MHz. The signals from the probes were photographed with a 5-beam cathode ray oscilloscope and the results were processed with a computer. Two excitation regimes of the LF oscillations can be distinguished: the first regime (pressure 2.4×10^{-4} Torr), the start of the current pulse, Fig. 1a, is characterized by excitation of LF oscillations that have a relaxation character and go over in time (after 30 - 40 μsec) into oscillations pertaining to the second regime. The latter includes also oscillations generated during the entire duration of the current pulse at a gas pressure in the system above 6×10^{-4} Torr, in view of the fact that the first regime terminates for these oscillations after several microseconds. We present in this paper results of an investigation of oscillations pertaining to the first regime.

The spectrum of the excited oscillations $S_{xx}(\omega)$, characterizing the first regime, consists of a fundamental frequency $\omega/2\pi \sim 560$ kHz and clearly

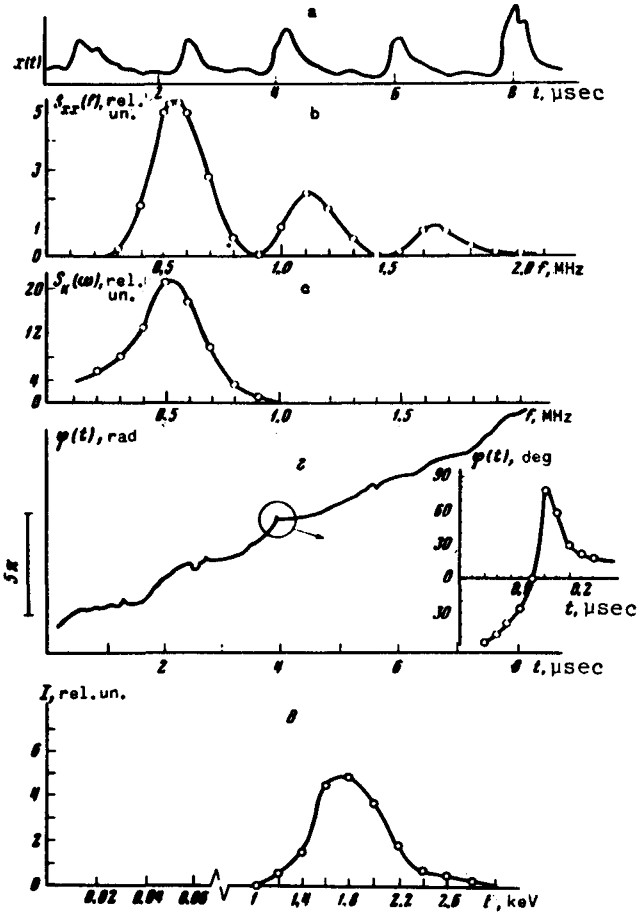

Fig. 1

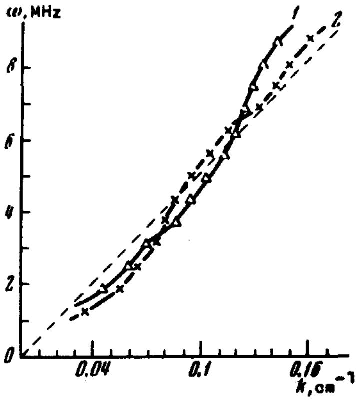

Fig. 2

pronounced harmonics (Fig. 1b). Figure 1c shows the spectral energy density of the excited oscillations $S_k(\omega)$ for a specified wave number $k \sim 0.1$ cm^{-1}. The ratio $\Delta\omega/\omega$ characterizes the degree of turbulence, where $\Delta\omega$ is the half-width of the $S_k(\omega)$ curve. For our case $\Delta\omega/\omega \sim 0.8$. Figure 1d shows the time variation of the phase of the electric field of the excited HF oscillations. The curve $\phi(t)$ curve itself describes only the change of the phase relative to a certain initial value, which is chosen arbitrarily. Attention is called to the fact that clearly pronounced jumps (up to 120°) are superimposed on the smooth variation of the phase.

If a wave propagates in the system with an average velocity u, then this leads to a time shift τ between the signals picked off by probes located at a distance ℓ. The calculated value of the wave velocity u is 4×10^7 cm/sec.

The measurements have shown that the frequency of the excited oscillations in the first regime does not depend on the magnetic field intensity and is inversely proportional to the square root of the ion mass. The experimentally determined growth increment of the oscillations is $\gamma \sim 4 \times 10^5$ sec^{-1}.

Specially performed correlation measurements have shown that the wave excited in the first regime is axially symmetrical.

In the case when a packet of plane waves propagates in the system

$$x(t,\ell) = \int_0^\infty A(\omega)\exp[ik(\omega)\ell + i\omega t]\,d\omega, \tag{1}$$

where $A(\omega)$ is the amplitude of the oscillations with cyclic frequency ω, the mutual power spectrum $S_{xy}(\omega)$ can be written in the following form [8]

$$S_{xy}(\omega) = S_{xx}(\omega)\exp[ik(\omega)\ell], \tag{2}$$

where $S_{xx}(\omega)$ is the spectrum of the excited oscillations. The plane-wave approximation is valid if

$$|S_{xy}(\omega)| = S_{xx}(\omega). \tag{3}$$

From relation (2) we can obtain the dispersion relation $k(\omega)$, which is shown in Fig. 2 for our case. Here 1 and 2 are the dispersion relations obtained for two values of ℓ (2 and 4 cm), unlike the results of [8], where a dispersion relation was obtained for the case of axially-asymmetrical waves ($\ell = 0$). The calculations were performed with a computer and were accurate to $\sim$20%. It follows from Fig. 2 that for LF oscillations excited in the first regime there exists a linear relation between ω and k ($\omega \sim ku$). The phase velocity u of the wave, calculated from the presented dispersion relation, is 5×10^7 cm/sec, which agrees with the indicated experimental value of the phase velocity. On the other hand, it was shown earlier [9] that under conditions of the first regime there is observed generation of mutually penetrating high-energy ion currents (current $\sim$2 A, ion density in the current 6×10^{10} cm^{-3} at a plasma density 5×10^{12} cm^{-3}), the energy spectrum of which is shown in Fig. 1e.

It follows from the spectroscopic measurements [9] that in our experiments $T_e \gg T_i$ ($T_e \sim 80 - 100$ eV, $T_i \sim 1$ eV) and the velocity of the ion sound is $u_s \sim (T_e/M)^{1/2} \sim 10^7$ cm/sec (hydrogen). Consequently in our case the Mach number is $M = u/u_s > 1$.

As shown in [10, 11] in the nonlinear case the velocity of a solitary ion-acoustic wave is a function of the amplitude of the wave and is expressed in the following fashion:

$$u^2 = \frac{1}{2} u_s^2 \frac{\{\exp[\frac{e\phi_{max}}{T_e}] - 1\}^2}{\exp[\frac{e\phi_{max}}{T_e}] - 1 - \frac{e\phi_{max}}{T_e}}, \tag{4}$$

where $e\phi_{max}$ is the energy acquired by the particle over the wavelength of the system λ_g. In the case of large amplitudes, when $e\phi_{max} \gg T_e$, we have $u > u_s$. When $M > 1.6$ there sets in the so-called multistream motion of the ions (mutually penetrating ion streams).

For our case $e\phi_{max} \sim eE\lambda_g \gg T_e$ ($eE \sim 100$ eV/cm, wavelength in the system $\lambda_g \sim 70$ cm). The electric fields were measured with a probing electron beam similar to that described in [12].

Thus, the presented data show that the first regime is characterized by excitation of nonlinear ion-acoustic oscillations. The experimental results are in qualitative agreement with the conclusions of [10, 11].

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SUPERCONDUCTIVITY OF GALLIUM ARSENIDE AT HIGH PRESSURES

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The semiconducting compound GaAs, which has a lattice of the type ZnS at a pressure p = 0, goes over into the metallic state at p = 250 kbar and room temperature [1]. A number of III - V compounds having a similar crystal structure (InSb, GaSb, and AlSb) go over into metallic modifications with the structure of white tin at respective pressures 22.5, 70, and 125 kbar. All these modifications are superconducting [2 - 4]. One might expect the metallic phase of GaAs to be likewise superconducting.

We report here observation of superconductivity in GaAs at pressures exceeding 250 kbar.

Pressures up to 300 kbar were produced at room temperature in a high-pressure chamber described in [5], using anvils of polycrystalline superhard materials of the SV type; the pressures were determined with a calibration curve based on the reference phase-transition points of Bi (p = 81 kbar), Fe (130 kbar), Pb (160 kbar), Fe + 8.4 wt.% Co (180 kbar), and GaAs (250 kbar). A force up to 4 tons was produced by a mechanical low-temperature press. The superconducting transitions were revealed by the change of the electric resistance. The sample temperature was measured with a semiconducting Allen-Bradley thermometer.

In the pressure region up to 250 kbar, the contact between the platinum electrodes and the sample produced a p-n junction with a resistance exceeding 10 megohm. The transition of the GaAs into the metallic state was revealed by the sharp decrease of the electric resistance to the value ∿3 ohm, which increased slightly with further increase of pressure. In the pressure region 250 - 300 kbar, the resistance of the samples upon cooling from 240 to 5°K decreased by approximately 4 times. With further lowering of the temperature, sharply pronounced transitions to the superconducting state were observed (see the figure). The temperature T_c of the transition into the superconducting state was 4.8°K at p = 260 kbar and decreased with further increase of pressure