the mass spectra of the combinations $(2\pi^+\pi^-)$ and $(\pi^+\pi^-)$. For comparison, the figure shows also the summary curves calculated with the "FORS" program for the reactions (2) and

$$\pi^- p \to 2\pi^+ 2\pi^- \pi^0 n \qquad (3)$$

The channels were summed with allowance for the experimental ratio of the meson interaction in the nucleus and the efficiency of γ-quantum registration in the chamber. We see that the experimental distributions duplicate qualitatively the calculated curves. Figure 2 illustrates at the same time the following conclusion: Since we know that the role of meson resonances in reactions (s) and (3) is negligible and that the corresponding mass spectra have a statistical character [3], the agreement between the experimental data and the calculated distributions shows that in our case the main contribution to the investigated reaction (1) is indeed made by the processes (2) and (3). This conclusion follows from a detailed analysis of the characteristics of reaction (1).

Conclusions: No process was observed with production of a virtual isobar in reaction (1). This means that the nucleus is transparent to an isobar with minimal momentum ~0.6 GeV/c. It is also possible that owing to the strong pion absorption in the nucleus the experiments isolate events of the reaction (1) occurring on the periphery of the nucleus.

In the main, the reaction (1) is determined by a process in which a virtual pion is produced and is subsequently absorbed in the nucleus.

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SUPER-ALFVEN RAREFACTION WAVE IN A PLASMA

A. T. Altyntsev, N. A. Koshilev, V. I. Krasov, V. L. Masalov, O. G. Parfenov, and A. A. Shishko
Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Siberian Division, USSR Academy of Sciences
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A super-Alfven rarefaction wave was seen to propagate in a magnetized plasma with $\beta \ll 1$ in a direction transverse to the magnetic field. At $\omega_{He}/\omega_{pl} \simeq 3\times10^{-2}$, the velocity of the wave reaches $(10 - 30)v_A$. The anomalously low conductivity σ points to a turbulent character of the processes in the wave front, where the penetration of the field has a diffuse character.

As is well known, the rate of penetration of a magnetic-field rarefaction pulse into a magnetized plasma is determined at $\beta = H^2/8\pi nT \ll 1$ by the Alfven velocity v_A. We present here experimental results showing that under certain conditions the rarefaction-wave velocity can reach $(10 - 30)v_A$, where v_A is determined from the initial plasma parameters.

The experiment was performed with the "UN-Phoenix" installation described in [1, 2]. A plasma with concentration $n_0 = 10^{11} - 10^{14}$ cm^{-3} and with initial temperature $T_0 = 1 - 5$ eV was produced in a cylindrical glass volume ($\ell = 100$ cm, diam 16 cm) placed in a quasistationary magnetic field ($H_0 = 10^2 - 10^3$ Oe, $\tau = 1.5$ msec). The working gases were H_2, He, and Ar. The rarefaction wave moving towards the system axis in a direction transverse to the initial magnetic field was excited by discharging a low-inductance capacitor into a shock loop 30 cm long. The field H of the shock loop was transverse to the initial field and assumed two values during the course of the experiment, namely $H^{\sim}$ = 1200 Oe ($\tau/4$ = 500 nsec) and $H^{\sim}$ = 200 Oe ($\tau/4$ = 250 nsec). The initial plasma density was measured with 4-mm and 8-mm radio interferometers. The initial plasma temperature was monitored with a triple Langmuir probe.

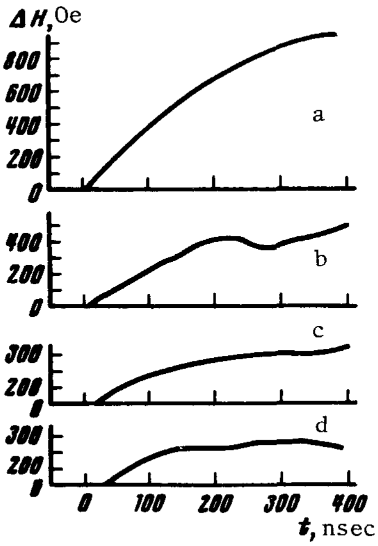

Fig. 1. Signals from magnetic probes ($\Delta H = H_0 - H$): a — magnetic field outside plasma volume; b,c,d — magnetic field inside plasma at distances r = 6.0, 4.5, and 3.0 cm from the axis, respectively; H_0 = 700 Oe, $n_0 = 4.5\times10^{13}$ cm^{-3}.

The radial propagation of the magnetic perturbation was investigated with the aid of magnetic H_z probes (3 mm diam). The probes were located in the central section of the shock loop (r_1 = 3.0 cm, r_2 = 4.5 cm, r_3 = 6.0 cm). Typical oscillograms of the signals from the magnetic probes are shown in Fig. 1. The rate of penetration of the magnetic perturbation into the plasma was determined from the starts of the $\delta H/\delta t$ signals, which were picked off simultaneously with the magnetic field.

Under the conditions of the experiment, the velocity u depends only on the initial plasma parameters n_0 and H_0, and it is convenient to represent this dependence in the form $u/v_A = f(v_A)$ (Fig. 2). It is seen that it has a resonant character and the maximal rate of penetration of the magnetic perturbation into the plasma is reached for different gases at the same value of $H_0/\sqrt{n_0}$, corresponding to $\omega_{He}/\omega_{pl} = 3.3\times10^{-2}$. Here ω_{pl} and ω_{He} are the plasma and cyclotron electron frequency, respectively. Under optimal conditions, u reaches values (20 - 30)v_A (for Ar).

It is seen from the oscillograms of the magnetic signals, obtained under optimal conditions with hydrogen (Fig. 1), that the penetration of the magnetic perturbation into the plasma is a nonstationary process, since the amplitude and the velocity of the disturbance decrease as the disturbance moves towards the axis of the system. The spatial dimension of the front of the magnetic signal is comparable with the radius of the plasma volume.

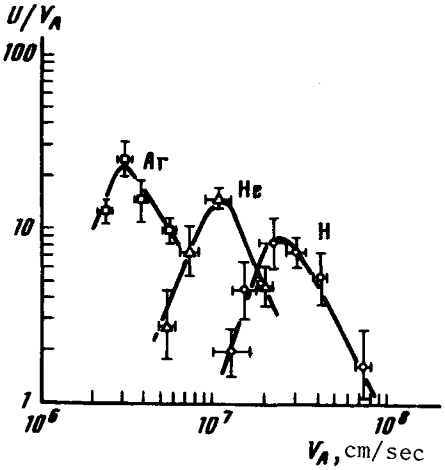

Fig. 2. Rate of penetration of magnetic-field rarefaction pulse, u, vs. the Alfven velocity v_A, for different gases (argon, helium, hydrogen).

Potential and electric measurements made under these conditions show that the ions are accelerated in the plasma in a direction opposite to that of the motion of the magnetic perturbation, and that their velocity does not exceed v_A.

This result is confirmed by direct measurements of the energy of the ions moving from the axis of the system; these measurements were made with an electrostatic analyzer of the charge-exchange neutrals.

Local measurements of the density, made in the front of the rarefaction wave with a microwave reflecting probe similar to that described in [3], have shown that during the initial stage of the signal (∿ 150 nsec) the density remains practically unchanged when the magnetic field in the plasma is changed by a factor 1.5 - 2.

We can conclude on the basis of the foregoing facts that under optimal conditions the penetration of the magnetic-field rarefaction pulse into the plasma has a diffuse character.

An estimate of the conductivity σ in the front of the rarefaction wave was obtained by the following methods: 1) estimate of σ from the dynamics of the radial distribution of the magnetic field, under the assumption that the penetration of the rarefaction pulse is described by the diffusion equation; 2) calculation of σ by Ohm's law using data from the electric probes (E_r, E_ϕ) and the azimuthal current density i_ϕ determined from the magnetic signals.

Under optimal conditions, both methods yield a value $\sigma \leq 10^{12}$ sec^{-1} for the conductivity. The classical plasma conductivity under the experimental conditions is 10^{13} - 10^{14} sec^{-1}.

Thus, in a magnetized plasma at $\omega_{He}/\omega_{pl} \simeq 3\times10^{-2}$ there can exist a super-Alfven rarefaction wave that moves across the magnetic field. The penetration of the magnetic-field rarefaction pulse into the plasma has a diffuse character. The anomalously low value of the conductivity in the front indicates that this diffusion is turbulent in nature.

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SINGULARITIES IN THE PROPAGATION OF HELICONS IN n-InSb IN THE QUANTUM LIMIT

B. A. Aronzon and B. Z. Meilikhov
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Alternation of regions of transmission and damping of a helicon in n-InSb as a result of variation of the magnetic field was observed in a field up to 200 kOe. The characteristic features of the phenomenon are attributed to singularities in the statistics and electron scattering in the quantum limit.

The propagation of weakly damped electromagnetic waves (helicons) in an electron plasma in semiconductors in quantizing magnetic fields has a number of singularities connected with the complex dependence of the diagonal components of the conductivity tensor on the magnetic field. Under these conditions, Furdyna [1, 2] observed Shubnikov - de Haas oscillations of helicon damping in n-InSb at 4.2°K in fields up to 100 kOe, and has shown, in addition, that in a sample with electron density $n = 1.1\times10^{16}$ cm^{-3} the damping of the helicon increases strongly in fields $\gtrsim 35$ kOe, owing to the growth of the transverse conductivity in the quantum limit with increasing magnetic field following scattering by ionized impurities in a degenerate electron gas [3]. We have investigated helicon propagation in n-InSb in stronger fields (up to 250 kOe), and observed the qualitatively new effects predicted in [4], namely, the appearance of alternating regions of "transparency" to and "absorption" of helicons.

Physically, these phenomena consist of changes in the character of the dependence of the dissipative conductivity $\sigma_{xx}(H)$ with increasing magnetic field. In a weak magnetic field (but one in which the quantum limit is reached) we have $\sigma_{xx} \sim H$ for degenerate electrons scattered by ionized impurities, so that the condition for weak helicon damping, $\sigma_{xx} < \sigma_{yx} = nec/H$, is violated in a certain field H determined by the condition $\sigma_{xx}(H_1) \sim \sigma_{yx} = nec/H_1$, and in fields $H > H_1$ the helicon is strongly damped. Further increase of the magnetic field lifts the degeneracy [5] (this is aided by the effect of magnetic "freezing" [6]) and leads to a dependence $\sigma_{xx} \sim H^{-2}$ [3], which ensures the appearance of a new region of weak helicon damping ($\sigma_{xx} < \sigma_{yx}$) in fields $H > H_2$, where H is determined by the condition $\sigma_{xx}(H_2) \sim \sigma_{yx} = nec/H_c$. In still stronger fields, the helicon damping can increase again (see below).

The experiments were performed at 32 GHz by an interferometer procedure at 32 GHz similar to that described in [1]. The figure shows the experimental results on helicons passing through n-InSb samples with electron density $n = 2\times10^{16}$ cm^{-3} at 78°K and 4.2°K. Unlike the interference pattern obtained at 78°K, the pattern at 4.2°K shows clearly the alternation regions of weak and strong helicon damping. The boundaries of these regions, $H_1 = 70$ kOe, $H_2 = 90$ kOe, and $H_3 = 160$ kOe, are marked in the figure.