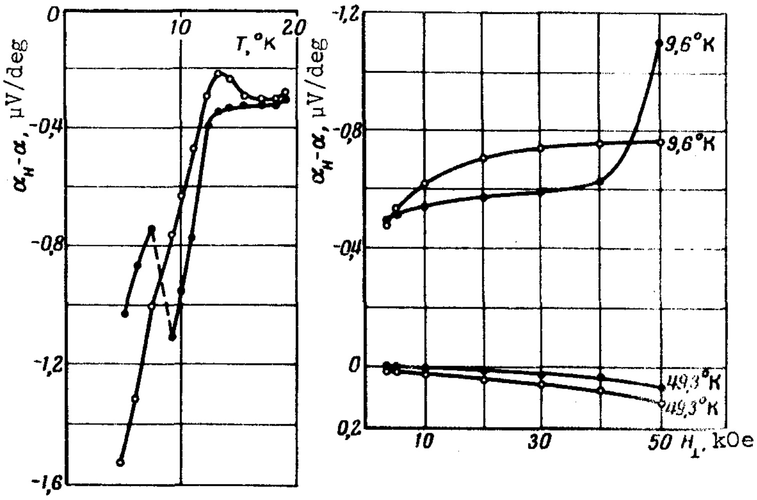

Fig. 2. Plots of $\alpha_H - \alpha$ vs. the temperature (left-hand side) and vs. the magnetic field intensity (right-hand side) for single-crystal aluminum in the directions $\phi = 0°$ (o) and $\phi = 30°$ (●).

The drop in the thermoelectric power, observed at 9.6°K in the $\phi \simeq 30°$ direction, may be connected with magnetic breakdown [9]. According to the experimental data, the width $\Delta\varepsilon$ of the energy gap, obtained from the temperature dependence of $\alpha_H - \alpha$, is of the order of $\sim 3.5 \times 10^{-4}$ eV, which is close to the values determined in [8].

Investigation of the anisotropy of the thermoelectric power at low temperatures in strong magnetic fields apparently uncovers wide possibilities for the study of the band structure of metals.

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CARRIER DRIFT IN LIQUID NEON AND ARGON

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The development of electronic methods for the detection of ionizing-particle tracks in liquid dielectrics (cf., e.g., our papers [1]) raises the question of the liquids in which free electrons can exist.

It has been established so far that free electrons are capable of moving in an electric field, with mobility $\sim 10^2 - 10^3$ cm^2/V-sec, through layers of heavy liquefied noble gases (argon, krypton, xenon) and of certain organic liquids [2, 3]. In many nuclear-physics problems it is important to use light elements as the detector working media. In liquid hydrogen or helium, unfortunately, the free electrons are localized in microscopic bubbles of radius ∿10 Å and have a mobility $\sim 10^{-2}$ cm^2/V-sec [4 - 6]. The use of liquid hydrogen or helium in the detectors of the type described in [1] entails great difficulties since the operating speed is smaller by five orders of magnitude than, say, in argon. The heaviest suitable element lighter than argon could be neon.

Using the same apparatus, we measured the ion drift velocities in liquid neon and argon. Argon was chosen to be the control medium. We used a three-electrode drift chamber with a tritium β source. This chamber and the measurement procedure are described in [4] and [7], respectively. The gases were purified by circulating them through calcium chips heated to 700°C. The gases were liquefied in a helium cryostat. The temperature of the liquids was determined from their vapor pressure. Since the temperature gradient inside the drift volume was not monitored, the results of different experimental runs differed somewhat. Our apparatus could not be used to measure the electron drift velocity, but the presence of a fast electronic current component in the liquid (say in argon) could be easily observed.

The measurements have shown that there is no fast (electronic) current component in liquid neon at all, and that the charges are carried by slowly drifting positive and negative carriers. The drift velocities of the carriers of both polarities (see Fig. 1) are quite close in the entire investigated temperature range from the triple to the critical point.

Figure 2 (bottom) shows the mobilities $\mu = dv/dE$ (v is the velocity and E the electric field intensity) and the carrier radii calculated by the Stokes formula (top). The models chosen were a bubble for the negative carrier and a

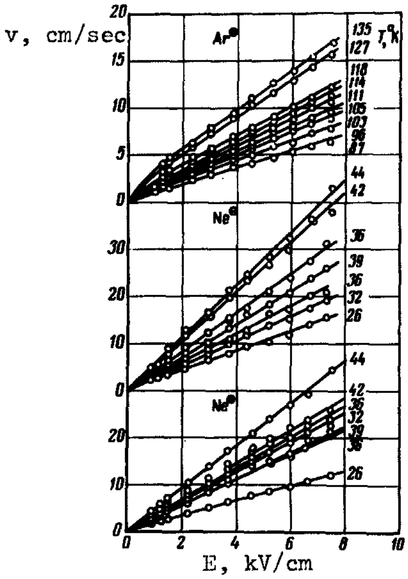

Fig. 1

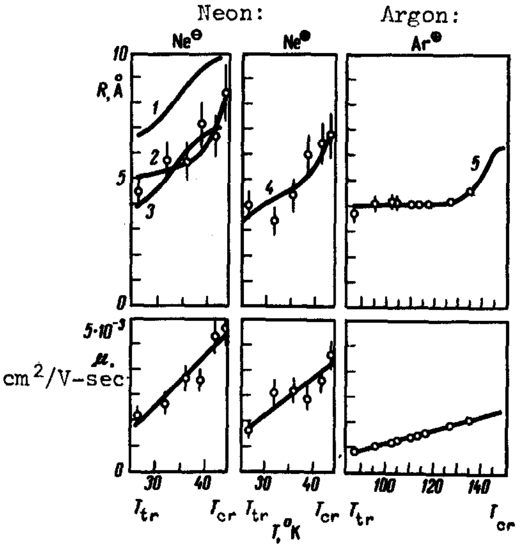

Fig. 2

Fig. 1. Carrier drift velocity v in liquid argon and neon vs. the electric field intensity E at different temperatures T of the liquids.

Fig. 2. Bottom: mobility $\mu = dv/dE$ vs. the temperature of liquid neon or argon. Top: carrier radius R vs. temperature: 1 - theoretical calculation of electron-bubble radii in neon [6]; 2 - experimental curve; 3 - the same as 1, but shifted downward by an amount equal to the diameter of the neon atom; it is obvious that the experimental points should lie between curves 1 and 3. Curves 4 and 5 - radii of the positive carriers in liquid neon and argon.

hard sphere for the positive one. We note that our results agree well with the predictions of the bubble model of negative carriers in neon [6], and also with the results obtained by others [2, 7, 8].

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TRANSITION EFFECT IN IONIZATION LOSSES OF HIGH-ENERGY PARTICLES

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Attempts have been made recently [1 - 3] to use the relativistic growth of the charged-particle ionization losses in the gas of a proportional counter to identify high-energy particles. An experimental verification of this possibility in [2] has revealed that for some unknown reasons the relativistic growth of the ionization losses at $\gamma = E/mc^2 \gtrsim 100$ is smaller than the expected one and amounts to 45% of the minimum value of the energy loss at $\gamma = 2000$, as against the 60% predicted by a theory that takes the density effect in gases into account [4]. It was shown in [3] that the experimentally measured ratio of the ionization losses of electrons and pions with momenta $P = 370$ MeV/c ($\gamma \simeq 740$ and 2.8, respectively) is at best 1.45 instead of the expected 1.78. Such a discrepancy between experiment and theory is unexpected, because in the case of solids the theoretical predictions are confirmed by experiment with accuracy ±1% [5]. It is important to ascertain the causes of such a discrepancy, since a weakening of the relativistic growth of the ionization loss creates additional difficulties in the problem of particle separation by masses, which is made complicated enough by the fluctuations of the energy losses.

The purpose of the present paper is to find a possible mechanism that explains the decrease of the ionization losses of relativistic particles in gas counters and to discuss methods that make a reduction of this effect possible.

A charged particle enters the gas of a proportional counter through the entrance window or through the counter wall; the thickness of either exceeds 25 μ. At such thicknesses, the particle field has time to become screened because of the polarization of the atoms in the medium, for only at thicknesses $\lesssim 10^{-5} - 10^{-4}$ cm can the particle ionize without the density effect [6]. On penetrating farther into the counter gas, the particle field is not immediately transformed into that of a particle in a gas. At a certain distance the particle "remembers its past," as it were, and continues to ionize with the field it possessed in the dense matter. Consequently, the ionization due to