diameter, and the beam penetrates through the plasma without undergoing qualitative or quantitative changes. Consequently, the current I at $E_0 = 0$ is proportional to n at all r. Figure 3 shows the plasma density profile $n(r) \propto I(r)$, measured in this manner. The figure shows also the radial dependence of the flux of the atoms produced by charge exchange with the residual gas. It is easy to show that the difference between this curve and n(r) agrees qualitatively with the expected difference.

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DEPENDENCE OF MULTIPLICITY OF SECONDARY PARTICLES ON THE ATOMIC NUMBER OF THE TARGET NUCLEUS AND ON THE ENERGY OF THE INCIDENT PARTICLE

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The growth of the multiplicity in the energy interval 50 — 3000 GeV fits satisfactorily a logarithmic law for many substances (H, CH_2, Cu). The coefficient of the logarithm increases with increasing atomic number. The data agree with the semi-inclusive scaling predictions.

Investigations of such nuclear-interaction characteristics as the distribution of the multiplicity n_s at ever increasing energies can cast light on the dynamic picture of the interaction. A study of the lower moments of the distribution, such as the average multiplicity $\langle n_s \rangle$, the variance, etc., and also of the correlation functions of the multiplicity, can reveal the main features of these processes and their connection with such fundamental characteristics as the cross sections. By the same token, more opportunities arise for narrowing down the class of acceptable models. On the other hand, a study of the dependence of the multiplicity on the atomic number of the target nucleus in a wide range of energies yields information on the high-energy processes in nuclear matter. The investigations in this direction used mainly the nucl nuclear-emulsion procedure. The shortcomings of this procedure, namely the indirect determination of the in-eraction energy, the lack of pure target nuclei and the resultant lack of distinct criteria for separating interactions with "light" and "heavy" nuclei, all decrease greatly the value of these laborious experiments.

The aim of our experiment was to investigate the aforementioned problems with the aid of pure targets, with good resolution of the secondary particles and with an independent estimate of the interaction energy. The work was performed with the new functioning section of the high-mountain setup of the G. E. Chikovani laboratory, situated in the southern Caucasus at an altitude of 2500 m.

Since the start of operation of the installation, in January 1973, some 12000 photographs were obtained, from which 375 events in a polyethylene target and 175 events in two copper targets of different thicknesses (18 and 8 g/cm^2) were selected. All events were broken up into three energy intervals with mean energies 70, 170, and 600 GeV. We measured the multiplicity of the secondary relativistic particles.

	H	$(CH_2)_n$	Cu	Ag, Br
a	- 0,8	- 1,2	- 2,2	- 5,2
b	3,8	4,4	6,4	8,8

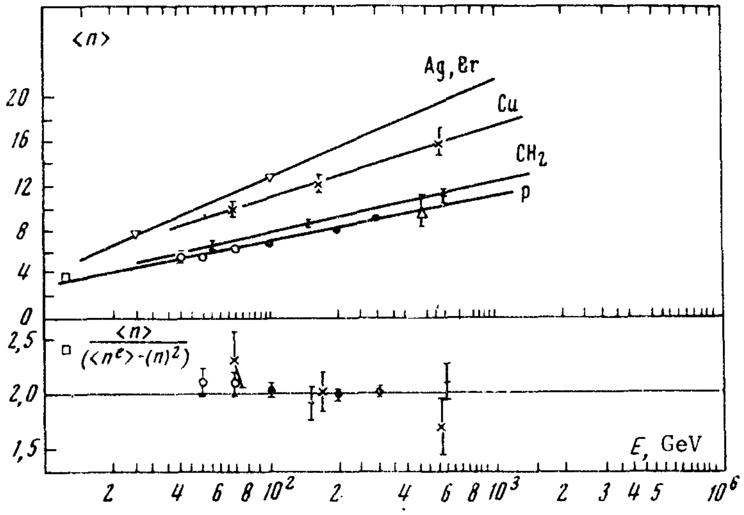

Fig. 1. Energy dependence of $<n_s>$ and $<n_s>/\sigma$: data from o) [1], ●) [2], Δ) [3], ∇) [4], □) [7]; ×, +) present data.

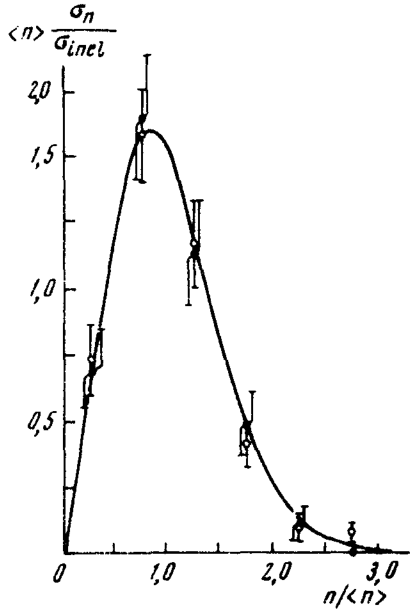

Fig. 2. Plot of $<n_s>\sigma_n/\sigma_{inel}$ against $n_s/<n_s>$ for CH_2: ●) 150 GeV, o) 600 GeV. The solid curve is a plot of the data of [6].

Figure 1a shows comparative known data obtained with the accelerators at Serpukhov, NAL, and ISR [1 - 3], a comilation plot of the emulsion results [3], and our data for Cu and CH_2. As seen for the diagram, for energies $E_0 > 50$ GeV the growth of the multiplicity is in satisfactory agreement with the logarithmic relation of the type $a + b \log E_0$. The table lists preliminary estimates of the coefficients a and b for the plotted relations. A monotonic growth of the slope of b was observed for the investigated substances with increasing atomic number of the target nucleus. This may be due to the many-particle interactions inside the target nuclei. The data are in satisfactory agreement with calculations based on the five-nucleus cascade picture [4].

Figure 1b shows the behavior of the ratio $<n_s>/\sigma$ as a function of the energy. If the multiplicity has a Poisson distribution, then this ratio should increase like $\sqrt{<n_s>}$. No such growth is observed, however. In the analyzed region there is a noticeable tendency for this ratio to stabilize with increasing energy, for all the investigated nuclei, at a value close to 2.

This behavior was predicted in [5] for nucleon-nucleon interactions. It follows also from [5] that the distribution of the ratio $n_s/<n_s>$ does not depend on the energy. Such a universality was indeed observed in [6] for energies $E_0 > 50$ GeV. We have plotted a similar relation for polyethylene (Fig. 2). It is well described by the curve obtained from accelerator data with hydrogen (solid curve). The universality can be traced up to 600 GeV.

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MECHANISM OF LOW-TEMPERATURE IMPURITY BREAKDOWN IN COMPENSATED SEMICONDUCTORS AND OF SWITCHING IN AMORPHOUS SEMICONDUCTORS

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The mechanism of switching in amorphous semiconductors has not been uniquely identified to this day. On the other hand, a switching effect was in fact observed also in crystalline semiconductors. As is well known, low-temperature breakdown in doped and compensated semiconductors has an S-shaped current-voltage characteristic1). The explanation of this effect is based on the fact that the breakdown is due to impact ionization of shallow impurities [1], and that after the start of the breakdown the electrons become redistributed in an even shallower level, ionization from which is more probable, as a result of which the voltage needed to maintain the breakdown is smaller than the ignition voltage E_{ig}. It was proposed, in particular, that the excited state of the shallow impurity center can be regarded as this level.

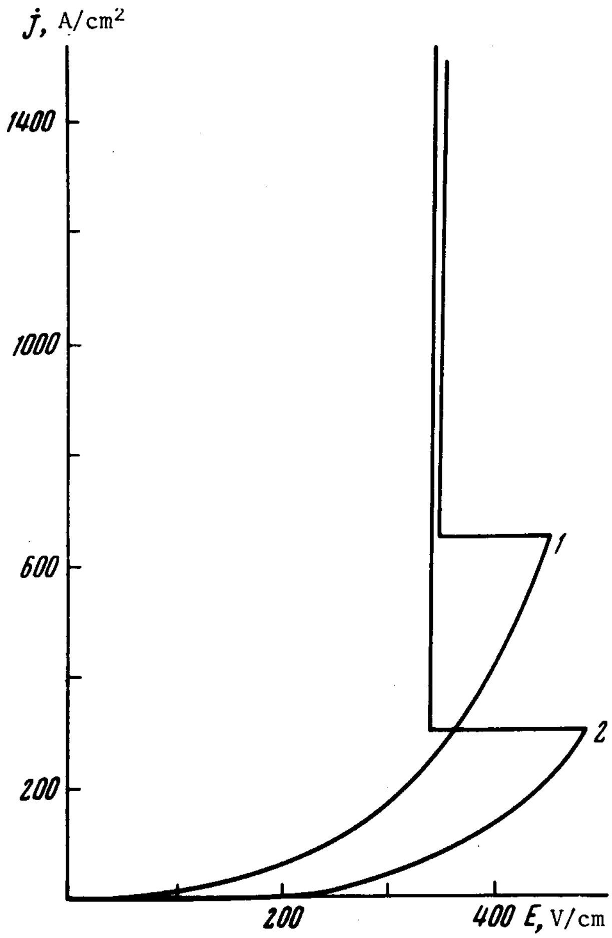

Fig. 1. Current-voltage characteristics of one of the SDC germanium samples: 1) 4.2°K, 2) 2.2°K.

It will be shown below that there is an analogy between these switching phenomena in crystalline and amorphous semiconductors. The experiments were performed by us on samples of strongly doped and compensated (SDC) germanium. In addition to being of independent interest (switching in SDC semiconductors has not been investigated before), the mechanism of switching in these samples is expected to be common also to a number of amorphous structure, owing to the similarity between the spectra of the electronic states in these systems [3].

At first glance, the mechanism of impact recombination in SDC and in amorphous semiconductors should call for too strong fields, owing to the great depth of the Fermi level. Thus, estimates [4] show that for a level of depth 0.1 - 0.2 eV the field should be of the order of 10^5 - 10^6 V/cm. In weakly doped crystalline semiconductors, however, when the shallow impurities are fully compensated by deep ones and no impact ionization is observed, it is still possible to effect this ionization by filling the shallow impurity centers (e.g., by illumination). This effect has first been described in [5] and is known as induced impurity breakdown. We shall show that an analogous phenomenon can take place in SDC and amorphous semiconductors. Indeed, at low carrier temperatures the carriers are localized in these semiconductors in the deepest wells of the potential relief, and charge