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IDENTIFICATION OF HIGH-ENERGY PARTICLES IN A STREAMER CHAMBER

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The relativistic rise in specific primary ionization has been measured in the mixtures: 50 Torr Ne + 50 Torr He + 2 Torr H_2O and 320 Torr Ne + 320 Torr He with an accuracy of 2.5%. The possibility is discussed of use of a streamer chamber for separation according to mass of particles with momentum up to 200 BeV/c.

THE possibility of precision measurement of specific primary ionization permits application of the streamer chamber to identification of high-energy particles in beams with a given momentum. This field of application of the streamer chamber has been discussed by us previously[1] for the case of a chamber filled with helium to a pressure of ~0.6 atm.

In the present work we investigate the question of a choice of optimal composition and pressure of the chamber gas for identification of particles in beams of the highest possible momentum.

It is well known[2] that with decreasing gas pressure the density effect, which limits the relativistic rise in ionization, shifts to the region of higher energies. However, on the other hand, with decreasing pressure of the chamber gas the statistical accuracy in ionization measurement becomes poorer, the diffusion of the electrons in the track increases so as not to permit measurement of the primary ionization, and in addition the quality of the tracks becomes poorer. We have established that the maximum reduction in pressure (to 100 mm Hg) without substantial deterioration in track quality is possible for a chamber filling of neon-helium mixture (50% Ne + 50% He). Here the electron diffusion can be reduced to the value necessary for primary ionization measurement, by adding a small concentration of an impurity with a large cross section for electron collisions.[3] Water vapor can be used for this impurity. For the case of a chamber filling of the mixture 50 Torr Ne + 50 Torr He + 2 Torr H_2O we have measured the relativistic rise in specific primary ionization in the electron energy interval from 30 to 570 MeV. The results of the measurements are shown in Fig. 1, where we have also plotted similar results for a chamber filling of 320 Torr Ne + 320 Torr He. It is evident from Fig. 1 that the experimental results are in good agreement with a calculation using the formulas of Ermilova et al.[2]

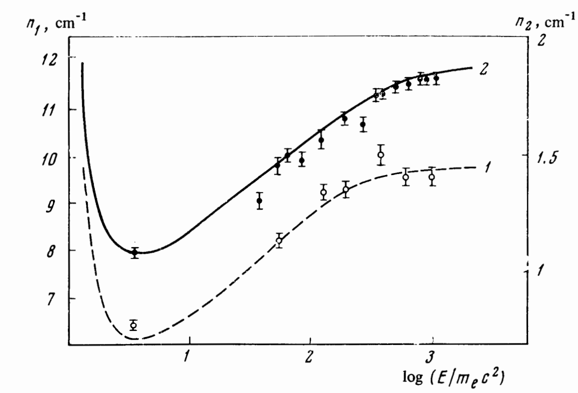

FIG. 1. Relativistic rise in specific primary ionization, measured in a streamer chamber. Solid points – chamber filled with a mixture 50 Torr Ne + 50 Torr He + 2 Torr H_2O; hollow points – a mixture of 320 Torr Ne + 320 Torr He. Curves 1 and 2 are calculations by the authors of ref. 2.

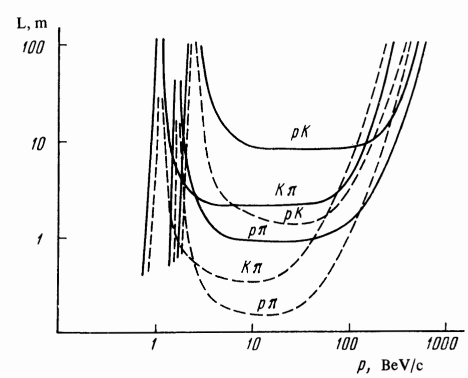

FIG. 2. Length of streamer chamber necessary for identification of particles of a given momentum. Solid curves – chamber filled with a mixture of 50 Torr Ne + 50 Torr He + 2 Torr H_2O; dashed curves – a mixture of 320 Torr Ne + 320 Torr He. The left portion of the curves corresponds to ionization losses of nonrelativistic particles (see Fig. 1). The reliability of the particle separation is 90%.

On the basis of the data of Fig. 1 we have calculated the necessary track length in the chamber for separation at the 90% confidence level of the particle pairs pπ, pK, and Kπ in a beam of given momentum. The results of this calculation are presented in Fig. 2. The peaks in the curves in the left-hand part of Fig. 2 should go to infinity, since they correspond to the point of intersection of the relativistic and nonrelativistic branches of the curves shown in Fig. 1 and belonging to different particles. Figure 2 also shows that reduction of the gas pressure in the chamber does not permit extension to the momentum region greater than ~200 BeV/c without increasing substantially the chamber length.

The last fact is due to the deterioration in the statistical accuracy in the ionization measurement and is a limitation in principle for all methods based on primary ionization measurement in the region of the relativistic rise in ionization loss.

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[1] V. A. Davidenko, B. A. Dolgoshein, V. K. Semenov, and S. V. Somov, Zh. Éksp. Teor. Fiz. 55, 426 (1968) [Sov. Phys.-JETP 28, 223 (1969)].

[2] V. K. Ermilova, L. P. Kotenko, G. I. Merzon, and V. A. Chechin, Zh. Éksp. Teor. Fiz. 56, 1608 (1969) [Sov. Phys.-JETP 29, 861 (1969)].

[3] V. A. Davidenko, B. A. Dolgoshein, S. V. Somov, and V. N. Starosel'tsev, Zh. Éksp. Teor. Fiz. 57, 84 (1969) [Sov. Phys.-JETP 30, No. 1 (1970)].

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