CALCULATION OF IONIZATION LOSS FLUCTUATIONS OF FAST HEAVY CHARGED PARTICLES

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In order to calculate the fluctuations of the ionization loss it is necessary to know the cross section of the energy transfer in the single collision of the primary particle with the atomic electron. Proceeding from the theory of Allison and Cobb [1] we suggest a more exact expression, which takes into account with better accuracy processes with a large energy transfer [2].

Using the properties of Fourier transform of ionization loss distribution function the simple formulas for the moments (mean, dispersion, etc.) have been obtained. For the value of asymmetry of the distribution

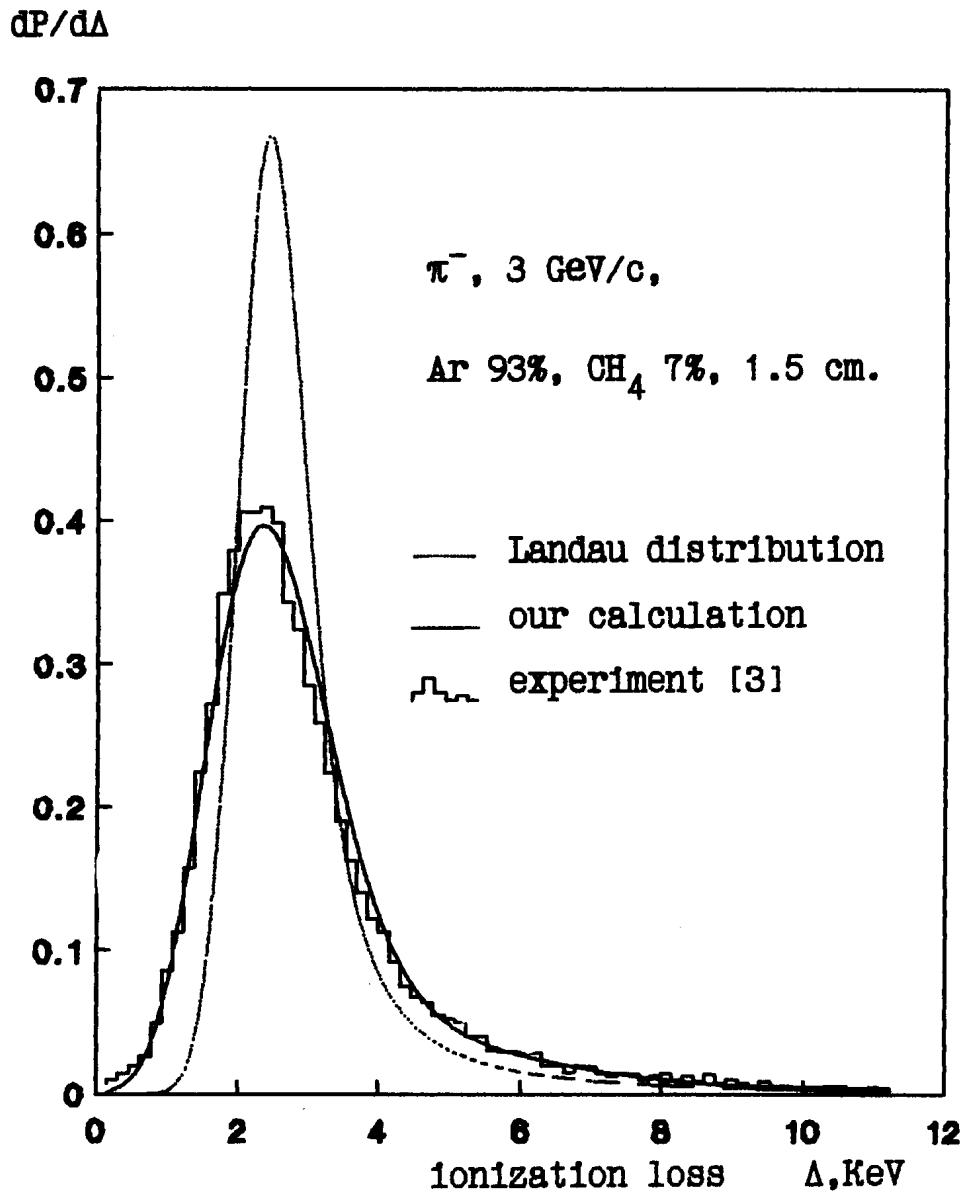

Fig. Experimental ionization loss distribution [3] and results of calculations. Additional straggling on Gaussian function corresponding to fluctuations of registration of ionization loss in proportional counter [2] were taken into account in calculations

function the approximate expression has been found:

$$A = \frac{1}{2}\sqrt{\frac{E_{max}}{\xi}},$$

where E_{max} is maximum energy of δ-electron, ξ is the parameter depending on the primary particle velocity and electron density of the material. The asymmetry decreases with the decrease of E_{max}. Therefore we can choose some small value of the asymmetry, calculate the corresponding threshold loss of energy in a single collision, and, after this, model fluctuations corresponding to lesser energy transfer on Gaussian function. One can take the asymmetry equal to 0.5. Under this condition the mean quantity of δ-electrons with the energy larger than the threshold energy will be no more than two or three electrons, and it almost does not depend on thickness of the layer. Using these important properties one can substantially accelerate the computations of ionization loss fluctuations [2].

We made the program system which calculates the distribution function and quickly produces the corresponding random numbers. The programs can be used in simulations of detectors and in treatment of experimental data by the method of maximum likelihood. The programs can calculate the fluctuations both in a thin layer of matter and in a very thin layer taking into account the atomic shell corrections. The results of the calculations correspond to the experimental data. The results of calculations for a very thin layer by our programs compared with Landau distribution and the experimental data are shown in the figure.

References

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