Universal description of the spectra of the Li^8 nuclei emitted by emulsion nuclei by bombardment with high-energy particles

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It is shown that the spectra of fast Li^8 fragments from emulsion nuclei can be described by the universal function $\rho=(E/p^2)(1/\sigma_{tot})(d^2\sigma/d\Omega dp) =[(1.66\pm^{0.9}_{0.5})\cdot 10^{-3}] \exp[-(4.6\pm 0.6)p^2]$.

It was observed[1] that the spectra of the protons and deuterons emitted backward from nuclei under the influence of particles of energy > 1 GeV can be described by the universal function

$$\rho = \frac{f}{\sigma_{tot}} = \frac{E}{p^2}\,\frac{1}{\sigma_{tot}}\,\frac{d^2\sigma}{d\Omega\, dp} = A\exp(-Bp^2).$$

Here E and p are total energy and momentum of the particle emitted backward, σ_{tot} is the total cross section for the interaction of the incident particle with the target nucleus, $d^2\sigma/dp\,d\Omega$ is the doubly-differential cross section in units of $[\text{mb/sr}(\text{GeV}/c)^2]$

$A = 2.8 \pm 0.7$ $\text{sr}^{-1}(\text{GeV}/c)^{-2}$, $B = 11.5 \pm 0.7$ $(\text{GeV}/c)^{-2}$ for protons,

$A = 0.31 \pm ^{0.5}_{0.15}$ $\text{sr}^{-1}(\text{GeV}/c)^{-2}$, $B = 8.5 \pm 1.2$ $(\text{GeV}/c)^{-2}$ for deuterons.

A and B do not depend on the initial energy, on the sort of the incident particle, or on the sort of the target

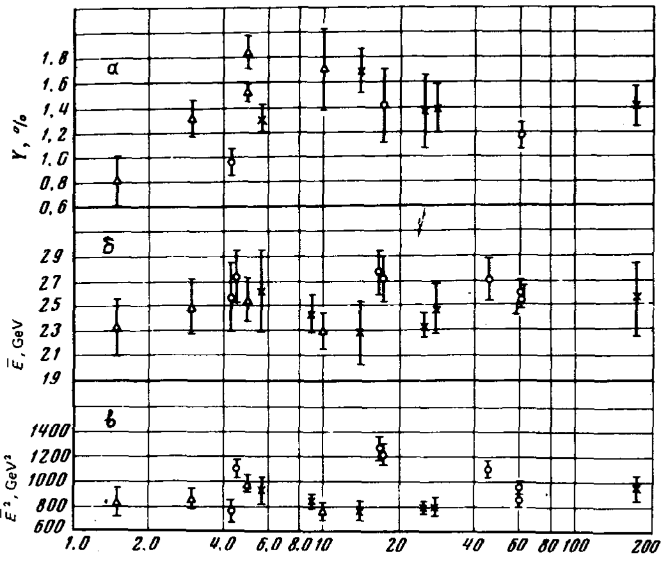

FIG. 1.

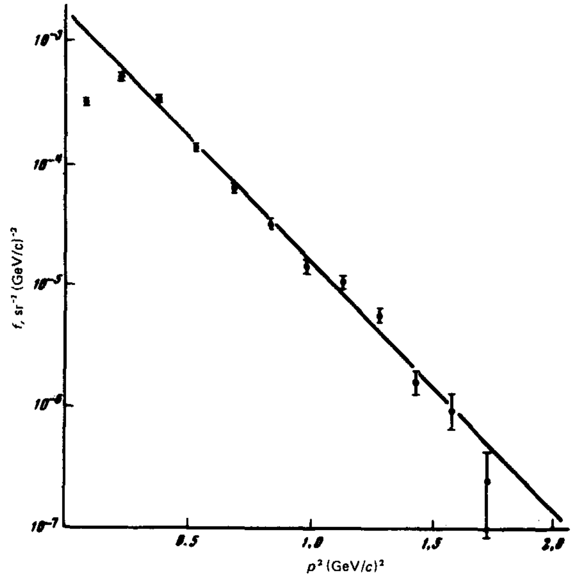

FIG. 2.

nucleus. In other words, the observed phenomenon is analogous to scaling in elementary-particle interaction. It is important that the only reactions considered were those in which several nucleons, or else the nucleus as a whole, took part in the interaction.

It is of interest to see whether a similar phenomenon takes place also when heavier fragments are emitted from a nucleus. We have analyzed the rather abundant data[2-16] on the emission of Li^8 fragments from heavy emulsion nuclei. These fragments produce tracks of distinct form and are therefore easy to identify. This the appearance of Li^8 certainly does not reduce to an interaction between an incident particle and an individual nucleon of the nucleus, and since the statistics obtained in each individual study are not plentiful, we shall consider the aggregate of all the interactions, regardless of the fragment-emission direction, all the more since the angular distribution of the Li^8 does not deviate greatly from isotropic.

All the Li^8 spectra are similar, and the relative yields do not depend on the initial energy or on the sort of incident particle. This is illustrated by the plots in Fig. 1, where 1a, 1b, and 1c represent the dependences of the relative yield, of the average energy, and of the rms Li^8 energy on the momentum of the incident particle in the range from 1.5 to 200 GeV/c. Different symbols on the plots pertain to different incident particles. The bars represent statistical errors. The absolute errors are undoubtedly larger, especially for the relative yields.

The observed universality of the spectra has allowed us to sum all the experimental data. The result, in the form of a plot of the function ρ against p^2, is shown in Fig. 2. We see that the experimental points, with the exception of the very smallest momenta $p^2 < 0.1$ (GeV/c)^2, are approximated by the relation

$$\left[\left(1.66 \begin{smallmatrix}+0.9\\-0.5\end{smallmatrix}\right)\cdot 10^{-3}\right]\exp -[(4.6 \pm 0.6)]p^2,$$

which naturally describes satisfactorily all the known experimental data on the yield of the Li^8 fragment. The errors shown in Fig. 2 are statistical.

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