# *TRANSVERSE MOMENTUM COMPONENT OF STRANGE PARTICLES PRODUCED IN PENETRATING COSMIC RAY SHOWERS*

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Results of measurement of the transverse momenta of strange particles produced by cosmic radiation are presented. It is shown that the mean value of the transverse momentum of heavy unstable particles is $(0.52 \pm 0.06)$ Bev/c. Within the limits of experimental errors it is independent of the type of strange particle and energy of the primary particle in the interval $(1-10) \times 10^{10}$ ev.

ONE of the most reliably established and interesting properties of nuclear interactions at high and very high energies is the constancy of the transverse momentum components of secondary $\pi$ mesons and their comparatively narrow distribution near a mean value of 0.3 to 0.5 Bev/c. On the other hand, the transverse momentum of nucleons, antinucleons, and strange particles remains almost entirely uninvestigated. Perkins[1] and Takibaev[1] assumed, on the basis of indirect data, that $P_t$, the transverse momentum component of particles other than $\pi$ mesons, has a broad distribution extending up to several Bev/c.

In the present work an attempt was made to measure directly the transverse momenta of strange particles ($\Lambda^0$, $\theta^0$, and $\Sigma^{\pm}$), recorded in the Elbrus laboratory by an arrangement consisting of a double cloud chamber in a magnetic field, the cloud chamber being triggered by penetrating cosmic-ray showers. A description of the arrangement and the method of treating the data on the decay of unstable particles has been given in papers by the staff of the laboratory.[2-7]

Used in the study of the distribution of the values of $P_t$ were twenty-five $\Lambda^0$, twenty-one $\theta^0$, and thirteen $\Sigma^{\pm}$ particles for which the point of generation and the geometric parameters of the shower responsible for their production could be established.

For all the showers generated in the upper absorber, and for part of the showers generated by neutral particles in the absorber between the two working volumes of the chamber, the direction of the generating particle was taken along the shower symmetry axis that divided the number of shower particles in half. The error committed in determining the angles between the primary particle

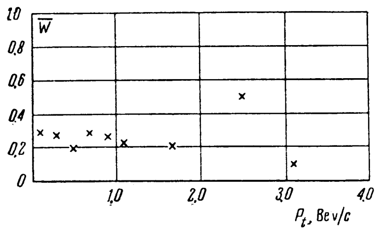



FIG. 1. Dependence of the experimentally observed mean probability of the recording of a decay $\overline{W}$ on the transverse momentum component $P_t$. The spread in the points at large $P_t$ is due to the small number of cases. $\overline{W} = n^{-1}(\Sigma 1/W_i)^{-1}$.

and the products of its nuclear interaction by this method was estimated by means of those cases for which the direction of the primary particle could be determined directly from its track in the upper volume of the chamber. To do this, we measured the angles of the shower tracks with respect to the direction of the primary particle and the axis of symmetry of the nuclear interaction. The mean-square error of the measurement of the angle between the primary particle and its products, determined from the difference between the respective angles, was 9°. It can be shown that such an error does not lead to any significant distortion in the shape of the distribution and in the mean value of $P_t$ in the case of strange particles produced in interactions of energy of the order of several tens of Bev.

Since the probability of recording the decay of an unstable particle in the chamber may depend significantly on the value of its transverse momentum, the distribution of the values of $P_t$ should be corrected for the probability of recording each case. To do this, the distribution was constructed with each decay assigned a weight $W_i^{-1}$, where $W_i$ is the a priori probability of its being recorded,

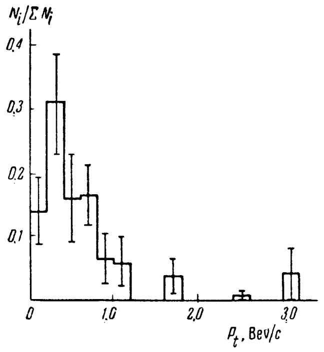



FIG. 2. Distribution of the transverse momentum components $P_t$ for all strange particles.

and the error in the number of cases in a given interval of values of $P_t$ was defined as $(\Sigma W_i^{-2})^{1/2}$. To demonstate the dependence of the probability of being recorded on $P_t$, Fig. 1 shows the probabilities $W_i$ averaged over cases with close values of $P_t$. It is seen that, up to transverse momenta of the order of 2 Bev/c, the probability of recording a decay cannot distort the distribution.

| | Number of cases | $\bar{P}_t$, Bev/c | $\bar{P}_t$ (Bev/c) omitting two cases with $P_t$ >2 Bev/c |
|---|---|---|---|
| All cases | 59 | 0.65±0.07 | 0.52±0.06 |
| Showers generated in upper absorber | 29 | 0.69±0.15 | 0.47±0.10 |
| Showers generated in absorber between chamber volumes | 30 | 0.57±0.06 | |
| $\Lambda^0$ hyperons | 25 | 0.45±0.06 | |
| $\theta^0$ mesons | 21 | 0.86±0.15 | 0.54±0.11 |
| $\Sigma^\pm$ hyperons | 13 | 0.72±0.19 | 0.64±0.14 |

Figure 2 shows the distribution of the values of $P_t$ with corrections for the probability of recording the decay for all 59 cases of decay of strange particles included in this analysis. The table lists the corresponding mean values of the transverse momenta $P_t$. The spectrum of the value of $P_t$ has the most probable value in the momentum region 0.2 to 0.4 Bev/c and extends up to 3 Bev/c. However, since the maximum measurable momentum in our arrangement was 2 Bev/c and the error in the sine of the angle between the line of flight of the unstable particle and the trajectory of the motion of the generating particle was of the order 0.12, both cases in which the transverse momentum is greater than 2 Bev/c may be due to errors in measurement. Since these cases, owing to their greater weight, produce a significant change in the mean values of the $P_t$ distribution, the table also shows the means values without these cases taken into account. The mean square value of all transverse momenta is shown in the first row of the table.

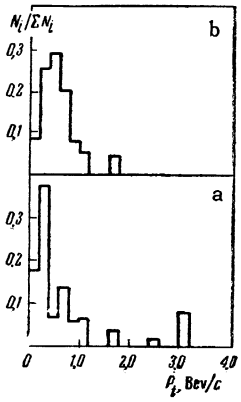
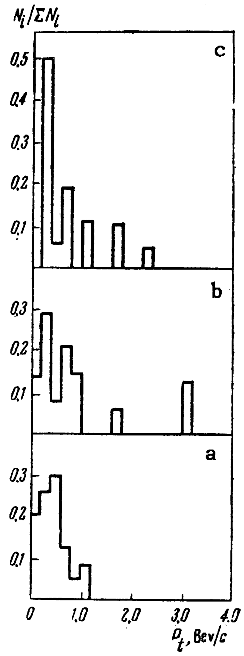



FIG. 3. Distribution of the values $P_t$: a – for particles generated in the upper absorber; b – for particles generated in the absorber between the two working volumes of the chamber.

Owing to the device for selecting the recorded interactions, the energy of the shower generated in the absorber above the chamber is several times the energy of the interactions generated in the absorber placed in the gap between the two volumes of the chamber. Therefore the separation of the overall distribution into cases recorded in the upper and lower volumes can give an idea of the energy dependence of the values of $P_t$ of heavy unstable particles in the energy region $(1 - 10) \times 10^{10}$ ev. Shown in Figs. 3a and 3b are respective distributions, which, apparently, indicate the absence of a dependence of $P_t$ on the energy, within the limits of experimental error. The weighted mean values of the transverse momenta are shown in rows 2 and 3 of the table.

FIG. 4. Distribution of the values of $P_t$: a – for $\Lambda^0$ hyperons; b – for $\theta^0$ mesons; c – for $\Sigma^\pm$ hyperons.




In Figs. 4a, 4b, and 4c the distributions of $P_t$ are separated according to the type of unstable particle. These distributions do not differ from one another within the limits of statistical error. The corresponding weighted mean values of the transverse momenta are given in the last rows of the table.

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[6] Z. Sh. Mandzhavidze, loc. cit. ref. 4 in press.

[7] Z. Sh. Mandzhavidze, loc. cit. ref. 4 in press.

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