индекс 3624

ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ
ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ

ЕФИ-409(16)-80

H.R.GULKANYAN, S.A.KORCHAGIN

A METHOD OF EXPERIMENTAL DETERMINATION OF DISTRIBUTION MOMENTS OF THE NUMBER OF INTERACTED NUCLEONS OF RELATIVISTIC NUCLEI

ԵՐԵՎԱՆ 1980 ЕРЕВАН

At solution of a number of problems on relativistic nuclear physics an experimental information on parameters of distribution of the number of projectile nucleus nucleons interacted with a target is necessary. Measuring and identification of non-interacted charged fragments (spectators) of the projectile allow to immediately define the distribution of the number of interacted protons. Direct measurement of distribution of the number of interacted projectile nucleons supposes a simultaneous detection of all spectators including neutrons, which is attended by evident, practically insuperable difficulties.

In this work we suggest a model-independent method of definition of distribution moments of the number of interacted projectile nucleons in inelastic nuclear collisions using experimental measurement of distribution of the number of interacted protons for nuclei with an arbitrary number of protons Z, and neutrons N. Here we admit that both proton and neutron of a projectile nucleus interact with the target in a similar way; we do not make any model assumptions on the mechanism of the projectile-with-target interaction, as well as on the nature of the target itself.

Denote the experimentally defined probabilities of m protons interaction by W_m $(m=1,\dots,Z)$, the probabilities of ν nucleons interaction of the incident nucleus by P_ν $(\nu=1,\dots,A \equiv Z+N)$. It is evident, that at the given fixed m the number of interacted neutrons may vary from zero (if $m>0$) or from unit (if $m=0$) to a maximum number N. Then the probabilities W_m may be presented as a sum of terms that mean probabilities of the fact that ν - nucleons have interacted, from whom m are protons and $(\nu-m)$ are neutrons:

$$W_m = \sum_{\nu=m}^{m+N} P_\nu C_Z^m C_N^{\nu-m} / C_A^\nu \qquad (m=1,\dots,Z)$$

$$W_0 = \sum_{\nu=1}^{N} P_\nu C_N^\nu / C_A^\nu . \qquad (1)$$

One may easily make sure that

$$\sum_{\nu=1}^{A} P_\nu = \sum_{m=0}^{Z} W_m \equiv 1 . \qquad (2)$$

Let us show that any moment $<\nu^M>$ of distribution of the number of interacted nucleons at $M \leq Z$ is unambiguously defined as a linear combination of experimentally measured probabilities W_m :

$$\sum_{m=1}^{Z} \alpha_m(M) W_m = <\nu^M> \equiv \sum_{\nu=1}^{A} \nu^M P_\nu \qquad (3)$$

i.e.

$$\sum_{m=1}^{Z} \alpha_m(M) \sum_{\nu=m}^{m+N} P_\nu C_Z^m C_N^{\nu-m} / C_A^\nu = \sum_{\nu=1}^{A} \nu^M P_\nu , \qquad (3a)$$

where $\alpha_m(M)$ $(m=1,\dots,Z)$ are a solution of a system of

linear equations

$$\sum_{K_{min}}^{K_{max}} \alpha_K(M) C_Z^K C_N^{\nu-K} = \nu^M C_A^\nu , \qquad (\nu=1,\dots,A), \qquad (4)$$

following from equality condition of the factors before P_ν $(\nu=1,\dots A)$ in the right- and left-hand sides of Eq.(3a). The values of summation limits in the left-hand sides of Eqs.(4) are given in Table 1.

Table 1

	$Z=N$		$Z<N$			$Z>N$		
	$\nu \leq Z$	$\nu > Z$	$\nu \leq Z$	$Z<\nu\leq N$	$\nu > N$	$\nu < N$	$N<\nu\leq Z$	$\nu > Z$
K_{min}	I	$\nu - N$	I	I	$\nu - N$	I	$\nu - N$	$\nu - N$
K_{max}	ν	Z	ν	Z	Z	ν	ν	Z

System(4) for the given moment of the M -th order contains Z unknowns $\alpha_K(M)$ $(K=1,\dots,Z)$ and A equations $(\nu=1,\dots,A)$. Let us prove that from the latters only Z equations are independent and the system (4) has a unique solution. To prove that, we use a combinatoric relation [1]

$$\sum_{S=0}^{n} (-1)^S (S+b)^\tau C_n^S = 0 , \qquad (5)$$

which takes place for integer values of τ within the limits $0 \leq \tau \leq (n-1)$ and for any real numbers b.

For simplicity we introduce new notations, omitting th index M :

$$\beta_K = \alpha_K (M) \, C_z^K \qquad (K = 1, \ldots, z). \qquad (6)$$

Multiplying each ν -th equation of the system

$$\sum_{K=K_{min}}^{K_{max}} \beta_K \, C_N^{\nu-K} = \nu^M C_A^\nu \qquad (\nu = 1, \ldots, A) \qquad (4a)$$

by $(-1)^\nu \, \nu^\tau$ and summarizing the obtained equations we shall have N relations ($\tau = 0, 1, \ldots, N-1$)

$$\beta_1 \Big[\sum_{s=0}^{N} (-1)^s (s+1)^\tau C_N^s\Big] - \beta_2 \Big[\sum_{s=0}^{N} (-1)^2 (s+2)^\tau C_N^s\Big] + \ldots \qquad (7)$$

$$+ (-1)^{z-1} \beta_z \Big[\sum_{s=0}^{N} (-1)^s (s+z)^\tau C_N^s\Big] = \sum_{\nu=0}^{A} (-1)^\nu C_A^\nu \, \nu^{M+\tau}.$$

All N relations (7) in virtue of relation (5) are identities of the type

$$\sum_{K=1}^{z} \beta_K (-1)^{K-1} \cdot 0 \equiv 0 , \qquad (8)$$

at $M + (N-1) \leq A - 1$, i.e. for the moments of the order $M \leq z$.

Thus, it has been proved, that the system (4a) has z independent equations. To find its solution it is sufficient to solve, e.g., its first equations

$$\sum_{K=K_{min}}^{\nu} \beta_K (M) \, C_N^{\nu-K} = \nu^M C_A^\nu \qquad (\nu = 1, \ldots, z). \qquad (9)$$

It is easy to be convinced that system (9) has a unique solution, since the matrix of the system is triangular and all its diagonal elements differ from zero (are equal to $C_N^0 = 1$). Substituting the values of α_K (M) defined from (9) and (6)

Table 2

M \ K	I	2	3	4	5	6
I	2	4	6	8	I0	I2
2	2	I2,8	32,4	60,8	98	$I44 = I2^2$
3	2	30,4	I5I,2	430,4	934	$I728 = I2^3$
4	2	65,6	586,8	3034,4	8429	$20736 = I2^4$
5	2	I36	2052	I5320	73270	$248832 = I2^5$
6	2	276,8	6764,4	76884,8	557I38	$2985984 = I2^6$

The obtained experimental values of moments may be used to check nuclear interaction models and to obtain predictions on characteristics of multiple production of particles in nuclear collisions.

The authors would like to express their gratitude to A.P.Gasparyan for useful discussions.

REFERENCE

1. A.I.Markushevich, "Vozvratnie posledovatelnosti", "Nauka", M., 1975.

The manuscript was recieved 13 March 1980

Г.Р.ГУЛКАНЯН, С.А.КОРЧАГИН

МЕТОД ЭКСПЕРИМЕНТАЛЬНОГО ОПРЕДЕЛЕНИЯ МОМЕНТОВ
РАСПРЕДЕЛЕНИЯ ПО ЧИСЛУ ПРОВЗАИМОДЕЙСТВОВАВШИХ
НУКЛОНОВ РЕЛЯТИВИСТСКИХ ЯДЕР
(на английском языке)

Ереванский физический институт

Тех.редактор А.С.Абрамян

Заказ 607 ВФ-05I46 Тираж 299

Препринт ЕФИ Формат издания 60x84/I6

Подписано к печати 7/У-80 0,7 уч.изд. ,Ц. 5 к.

Издано Отделом научно-технической информации
Ереванского физического института, Ереван-36, пер.Маркаряна 2