On the Descrption of Multiplicity Distributions of Negative Particles in Hadron ($\bar{q}$, π^-, K^-)-Nucleus (Li, C, S, Cu, CsI, Pb) Interactions at 40 GeV/c.

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Summary. – A universal description of multiplicity distributions of negative particles is analysed for hA interactions at 40 GeV/c.

It is known (1) that the KNO function with the Slattery parametrization (2) and the modified KNO function used by BURAS *et al.* (3) are not universal and depend on the incident particles. The aim of this paper is to describe the negative-particle multiplicity distributions for hadron-nucleus collisions in terms of a function having two parameters. This function gives an excellent description of all published KNO moments ($C_k = \langle n^k \rangle / \langle n \rangle^k$) for pp interactions at Serpukhov, FNAL and ISR energies (4) and this function describes the multiplicity distributions e^+e^- at PETRA energies (5) too. The analytical form of this function was determined by the generalization of the constraint method (4). In addition, a parton model leads to the same function (5) and this can be regarded as the underlying explanation of the form used by us.

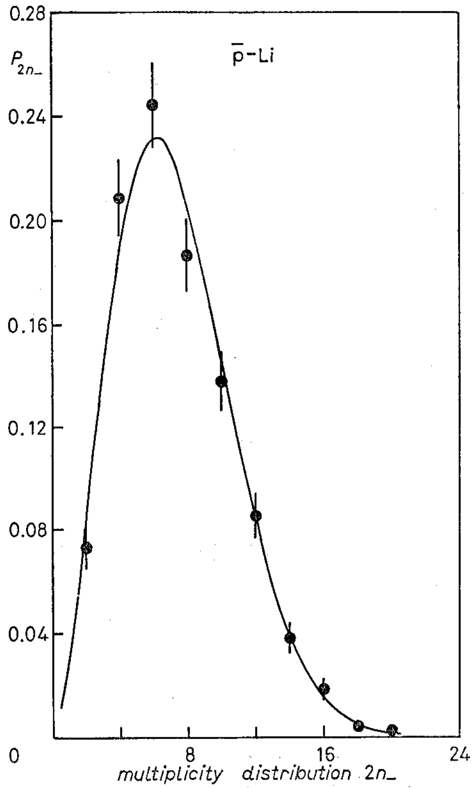

Fig. 1.

(1) N. H. KHAHN, J. LABERRIGUE, H. K. NGUYEN, A. M. TOUCHARD, J. M. LAFFAILLE, R. BARLOUTAUD, A. BORG, C. LOUEDEC, C. COMBER, D. J. CRENNEL and K. PALER: *Proceedings of X International Symposium on Multiparticle Dynamics GOA, India, 1979*, edited by S. N. GANGULI, P. K. MALHOTRA and A. SUBRAMANIAN, p. 176.

(2) P. SLATTERY: *Phys. Rev. D*, **7**, 2073 (1973).

(3) A. J. BURAS, J. DIAS DE DEUS and R. MØLLER: *Phys. Lett. B*, **47**, 251 (1973).

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This function is the following:

$$P_{n_{\rm ch}} = \frac{4}{\langle n_{\rm ch}\rangle \Gamma(A)} \left(\frac{\Gamma^2(A+\frac{1}{2})}{\Gamma^2(A)}\right)^A \left(\frac{n_{\rm ch}}{\langle n_{\rm ch}\rangle}\right)^{2A-1} \exp\left[-\frac{\Gamma^2(A+\frac{1}{2})}{\Gamma^2(A)}\left(\frac{n_{\rm ch}}{\langle n_{\rm ch}\rangle}\right)^2\right], \tag{1}$$

where $A = \frac{1}{2}\, C_2/(C_3 - C_2)$ and $\langle n_{\rm ch}\rangle$ are the parameters depending on the energy of the collision and on the incident particles. We can see that this is a KNO function in asymptotic limit, when A tends to a constant value.

A fit of parameter A was carried out to experimental data $\tilde{P}_{n_{\rm ch}}$, while $\langle n_{\rm ch}\rangle$ was taken from experiment. For technical reason a formal quantity $n_{\rm ch}$ was introduced by $n_{\rm ch} = 2 \cdot n_-$.

If the theoretical function (1) yields $\tilde{P}_{n_{\rm ch}}$, then the multiplicity distribution of negative particles $\tilde{P}^{(-)}_{n_-}$ can also be described in the same way. Because of the scaling property

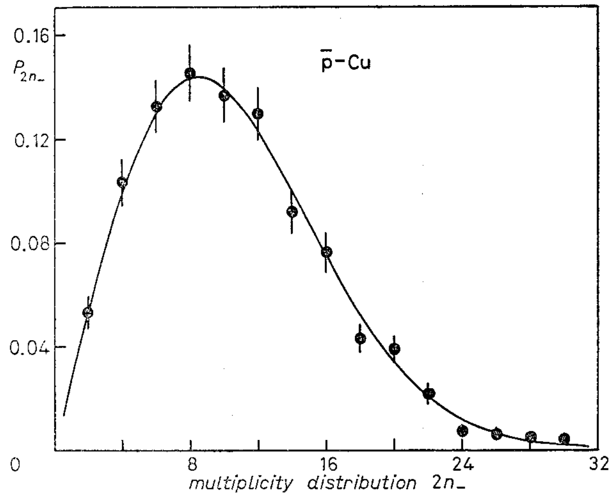

Fig. 2.

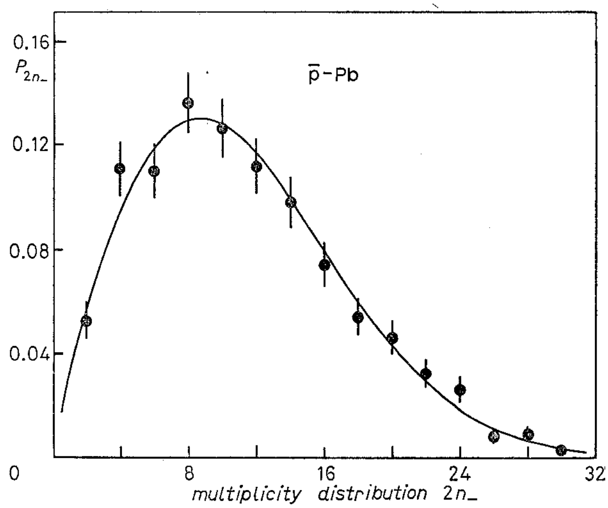

Fig. 3.

(at constant A) of formula (1),

$$P_{n_-}^{(-)} \equiv P_{2n_-} = \frac{1}{\langle 2n_- \rangle} \Psi\left(\frac{2n_-}{\langle 2n_- \rangle}\right) = \frac{1}{2} \frac{1}{\langle n_- \rangle} \Psi\left(\frac{n_-}{\langle n_- \rangle}\right).$$

For visual consideration a few examples are shown in fig. 1, 2 and 3. These figures display the comparison between $\bar{p}$-Li, $\bar{p}$-Cu and $\bar{p}$-Pb data at 40 GeV/c and the proposed distribution (1) of the parameters given in table I.

TABLE I.

Interaction	Parameter A	Observed $2\langle n_- \rangle$	$\chi^2/(N-3)$	N	Number of events
$\bar{p}$-Li	1.24	7.31 ± 0.26	1.31	10	1125
K^--Li	1.17	6.31 ± 0.35	0.91	9	543
π^--Li	1.41	6.61 ± 0.80	1.46	8	252
$\bar{p}$-C	1.16	7.81 ± 0.28	1.18	10	1094
K^--C	1.34	6.97 ± 0.38	0.66	10	475
π^--C	1.21	7.41 ± 0.39	1.32	10	489
$\bar{p}$-S	0.94	8.69 ± 0.31	0.84	14	1125
K^--S	1.05	7.62 ± 0.40	1.02	11	517
π^--S	1.03	7.45 ± 0.54	0.23	10	302
$\bar{p}$-Cu	1.01	10.61 ± 0.33	0.96	15	1407
K^--Cu	1.11	8.01 ± 0.59	2.22	10	260
π^--Cu	1.19	8.56 ± 0.81	0.73	11	153
$\bar{p}$-CsI	0.98	11.42 ± 0.40	1.67	16	1059
K^--CsI	1.02	9.70 ± 0.74	0.50	13	239
π^--CsI	1.04	9.80 ± 0.87	0.81	13	175
$\bar{p}$-Pb	0.93	11.29 ± 0.40	0.91	16	1102
K^--Pb	0.91	9.43 ± 0.55	1.23	15	411
π^--Pb	0.97	10.53 ± 0.75	0.73	13	269

From table I we can see the results of fits to the experimental distributions of $2n_-$ particle multiplicities for hadron ($\bar{p}$, K^-, π^-)-nucleus (Li, C, S, Cu, CsI, Pb) collisions at 40 GeV/c. As can be seen from this table the agreements with the individual experiments are reasonable and only one distribution has a slightly larger $\chi^2/(N-3)$ value for K^--Cu. Thus we can state that the proposed function (1) at a given laboratory energy 40 GeV is universal and only its parameters A and $\langle n_{ch} \rangle$ are dependent on the type of incident particles. We conclude that the proposed formula gives a reasonable description not only for the pp and e^+e^- multiplicity data in a large range of energy, but also for the negative-multiplicity data of hadron-nucleus collisions (with the atomic-mass number ranging from 7 to 207) at 40 GeV/c.