LETTERS TO THE EDITOR

SOME CHARACTERISTICS OF 22·8 GeV/c p AND 50 GeV/c π^--NUCLEI INTERACTIONS

From the number of grey, shower and heavy tracks in an interaction in nuclear emulsion, an attempt has been made to estimate the inelasticity, the number of collisions of the incident particle within the nucleus, the number of secondary particles absorbed inside the nucleus and participating in the further generation of particles at 22·8 GeV/c p and 50 GeV/c π^--nuclei interactions.

In this paper a systematic investigation of the interactions of 22·8 GeV/c p and 50 GeV/c π^--with nuclei of the nuclear emulsion has been made in an attempt to estimate the inelasticity K, the number of collisions ν of the incident particle within the nucleus, the number of created pions absorbed inside the nucleus and the number of created pions participating further in the generation of more secondary particles. For this purpose use has been made of the easily accessible information of the interaction, *viz.*, the number of grey (n_g), heavy (n_h) and shower (n_s) particles only. The results obtained have been compared with the investigations of other workers[1-3] The two show excellent agreement.

The experimental details and the procedure adopted to collect the present sample of interactions has been reported earlier[4-6]. All measurements have been carried out on leitz microscope. To check the biases creeping in the exact determination of the number of particles emitted in an interaction, the procedure adopted earlier has been used. Interactions have been classified into light and heavy ones by following the general practice adopted in nulear emulsions[3,7].

If η be the overall elasticity for all the collisions of the incident nucleon inside the nucleus, an estimate of η is then given by

$$\eta = (E_p - N \,.\, \langle E \rangle)/E_p \qquad (1)$$

where N and $\langle E \rangle$ are the number of particles excluding the primary and the mean energy of the secondary particles created in all collisions. If in an i-th collision of the primary particle X_i particles are created with mean energy $\langle E \rangle_i$ the conservation of energy then requires,

$$\eta^{i-1}(1-\eta)\, E_p = X_i \langle E \rangle_i. \qquad (2)$$

Substituting the value of $(1-\eta)$ from (1) we get

$$\eta^{i-1} = X_i \langle E \rangle_i / N \,.\, \langle E \rangle. \qquad (3)$$

Since, the available energy (E_p) for every collision s almost the same[4], equation (3) can be written as,

$$\eta = (1/\nu)^{1/i-1}, \qquad (4)$$

This equation holds good for values of i from 1 to ν. The overall value of η can be written as,

$$\bar{\eta} = \{ \sum_{i=1}^{\nu} (1/\nu)^{1/i-1} \}/\nu. \qquad (5)$$

Knowing ν one can determine $\bar{\eta}$ and hence the inelasticity K. In the present experiment the value of ν has been determined as follows:

In the first approximation, the total number N of the secondary particles excluding the persisting primary is given by $1\cdot5\ (n_s - 1)$. For the case of cascade process ν is estimated from the value of grey (n_g) and heavy (n_h) prongs in the event. It is well known that 75% of the grey tracks are due to recoiling protons. Hence, the total number of recoiling protons and the neutrons becomes $1\cdot5\, n_g$. The contribution to n_g due to secondary processes inside the nucleus is not ruled out. For some of the pions created in the first collision may either get absorbed or get inelastically scattered creating more pions in their collisions with other nucleons of the nucleus, whereas others may escape without any further interaction. Obviously, these secondary phenomena are statistical in nature and their cross-sections depend among other things, upon the energy of the pions. Therefore, using the experimental information[6] about the pion interactions for a wide energy range, the average behaviour of these processes have been accounted for as follows[9]:

The total number n_{as} of pions which are absorbed or scattered inelastically is given[10] by $n_{as} = n_h/\langle n_h \rangle$, where $\langle n_h \rangle$ is the average number of heavy prongs produced per pion interaction. If a is the fraction of pions which are absorbed $a \times n_{as}$ will be the number of pions which are absorbed, and $(1-a)\, n_{as}$ the number of pions which are inelastically scattered. Using the experimental information given by Chamberlin *et al.*[10], *viz.*, $\langle n_h \rangle = 3$ and $a = 0\cdot70$. The number of pions absorbed inside the nucleus is given by

$$a\, n_{as} = 0\cdot70 \times n_h/3 = 0\cdot23\, n_h$$

and the number of pions making inelastic collisions as,

$$(1-0\cdot70)\, n_{as} = (1-0\cdot70)\, n_h/3 = 0\cdot1\, n_h.$$

There should be thus $0\cdot1\, n_h$ recoiling nucleons due to the inelastic scattering of the created pions. Using this correction the value of ν was taken to be $(1\cdot5\, n_g - 0\cdot1\, n_h)$.

One can make an estimate of the number of charged pions n_c, created in a pion nucleon collision by using the logarithmic law[6,11] $n_c = 5\cdot92\ L_n\ \langle E \rangle - 0\ 99$ provided $\langle E \rangle$ the energy of the created pion is known, The number of charged pions created in $0 \cdot 1\, n_h$ collisions is $(0 \cdot 1\, n_h) \times [5 \cdot 92 \, \mathrm{Ln} \langle E \rangle - 0 \, 99]$. On taking into account the contribution of these secondary processes, the total number of secondary particles N comes out to be,

$$N = 1 \cdot 5 [(n_s - 1) - 0 \cdot 1\, n_h \times \{5 \cdot 92 \, L_n \langle E \rangle - 0 \cdot 99\}] + 0 \cdot 23\, n_h.$$

The total number of final state particles including the persisting primary is given by $N' = N + 1 \cdot 5$.

The values of the various parameters estimated have been displayed in Table I. Here n_1 is the number of created pions absorbed inside the nucleus, n_2 is the number of pions scattered inelastically inside the nucleus. K, ν and n_{as} have been defined earlier. As expected the number of collisions in case of interactions with heavy nuclei is much greater than that with the light nuclei. This consequently increases the value of K, n_1, n_2 and n_{as}. Further, a comparison of ν at these two energies shows that the cascade mechanism is more prevalent at 22·8 GeV/c than at 50 GeV/c. This clearly supports our earlier result[4], *i.e.*, with increase in the primary energy the tube mechanism takes over the cascade process.

TABLE I

The values of various parameters for light and heavy nuclei

ENERGY GeV	LIGHT n_{as}	K	n_1	n_2	ν	HEAVY n_{as}	K	n_1	n_2	ν
50 (π − N)	1·51 ± 0·1	0·66 ± 0·06	0·46 ± 0·03	1·05 ± 0·07	1·3 ± 0·06	3·27 ± 0·3	0·73 ± 0·04	0·98 ± 0·08	2·28 ± 0·10	4·69 ± 0·6
22·8 (p — N)	1·38 ± 0·1	0·63 ± 0·05	0·40 ± 0·05	0·98 ± 0·08	1·8 ± 0·15	5·09 ± 0·9	0·73 ± 0·03	1·5 ± 0·09	3·5 ± 0·2	5·63 ± 0·07

The value of K obtained in the present investigation are in good agreement with the ones obtained by K. Rybicke[1] and Gieurla[2] at different energies. Bhowmik and Shivpuri[3] using the experimental information about the energy and momentum of the secondaries have also estimated the value of ν and K in 22·8 GeV/c p-light nuclei interactions. The findings of the present investigation are in good agreement with their[3] observations. From the present investigation and the work carried out earlier[1-2] it seems that at these energies not more than two nucleons participate in the interaction in case of light nuclei and in heavy nuclei not more than six nucleons participate.

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Department of Physics and Astrophysics,
University of Delhi,
Delhi 110007. *November* 27, 1975.
S. K. KAUL.*

* Present address: Medical College, Jammu, J. & K. State.

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ROTATIONAL ANALYSIS OF A − X AND B − X SYSTEMS OF INDIUM MONO BROMIDE MOLECULE

THE spectrum of Indium mono bromide molecule in the region λλ 3600–3800 Å was studied in low dispersion by M. Wehrli and E. Miescher (1934) and A. Lakshminarayana and P. B. V. Haranath (1970). Barrett and Mandel (1958) studied the spectrum in absorption in the microwave region and obtained the rotational constants for the ground state. The present work was undertaken to know the exact nature of the excited states involved for