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CHARACTERISTICS OF π^--MESON MULTIPLICITY DISTRIBUTIONS IN CENTRAL COLLISIONS OF ^{12}C AND ^{16}O WITH NUCLEI AT P = 4.5 GeV/c PER INCIDENT NUCLEON

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The experimental data on central nucleus-nucleus collisions (CC) of ^{16}O with Ne, Pb and ^{12}C with C, Ne, Cu, Zr and Pb, analyzed in this paper, have been obtained using the 2m neon filled streamer chamber (SKM-200) exposed to a 4.5 GeV/c per nucleon beam extracted from the Dubna synchrophasotron.

A detailed description of the setup is given in paper [1]. Here we note that the solid targets were mounted inside the fiducial volume of the chamber and had a thickness of about 0.25 g/cm^2. The criterion of interaction "centrality" was the absence of charged projecile fragments in a narrow forward cone.

The events were selected by means of a veto counter of charged projectile fragments placed downstream the chamber. The counter covered such a solid angle that the emission angle, θ, of the fragments was $\gtrsim 2°$ (more detailed description of the triggering system see in ref. [2]). A part of the statistics was obtained with the use of a veto counter of neutral projectile fragments as well which had almost the same angular aperture and the efficiency of registering a single neutron ≈ 0.9.

If the triggering mode is denoted by $T(\theta_{ch}, \theta_n)$, where θ_{ch} and θ_n are the veto angles (in degrees) for emission, respectively, charged and neutral projectile fragments, then the selection criteria and the samples obtained are as follows:

T(2,0): ^{12}C + C, Ne, Cu, Zr, Pb (the sum of events over all the target $\Sigma N_i = 7014$); ^{16}O + Ne, Pb ($\Sigma N_i = 1474$).

T(2,2): ^{12}C+C, Ne, Zr ($\Sigma N_i = 2180$).

Since a further selection of events was made while scanning, not spatial but projected emission angles were used thus strengthening the criteria of collision "centrality". (Later on these angles are denoted in triggering mode designations in the same way). At this stage from each of T(2,0) and T(2,2) samples two subsamples were selected which included the events showing no charged projectile fragments with a momentum of $P \geq 3$ GeV/c emitted forwards within a projected angle of $\pm 4°$ and $\pm 14°$. In this way four subsamples were obtained using the selection criteria T(4,0), T(4,2), T(14,0), T(14,2).

Figure 1 presents the dispersions (D_-) of the π^--meson multiplicity distributions ($P(n_-)$) versus $\langle n_- \rangle$ for the T(2,0) and T(4,0) samples. The curve corresponds to the Poisson distribution ($D = \sqrt{\langle n \rangle}$). The line $D_- = 0.58\langle n_- \rangle + 0.3$ (the so-called

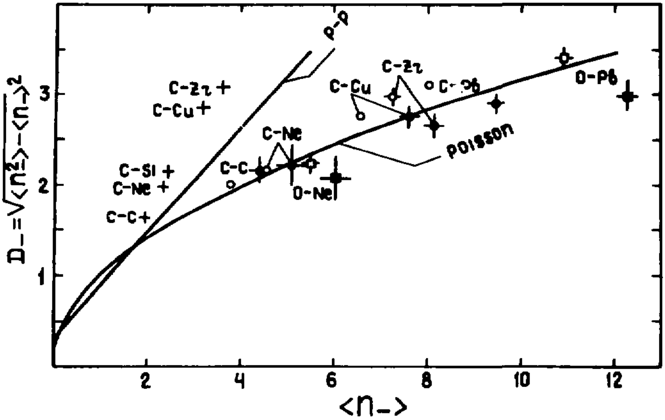

Fig.1. The dispersion $D=\sqrt{\langle n^2\rangle-\langle n\rangle^2}$ versus $\langle n\rangle$ for $P(n_-)$ in inelastic $^{12}C+A$ interactions (+) and in central $^{12}C+A$(o) and $^{16}O+A$(□) collisions at a veto angle of $\theta_{ch}=2°$ for charged projectile fragment emission. ● – $^{12}C+A$ at $\theta_{ch}=4°$. ■ – $^{16}O+A$ at $\theta_{ch}=4°$. The curve $D=\sqrt{\langle n\rangle}$ corresponds to the Poisson distribution and the line to the $P(n_-)$ distributions in pp interactions.

Wroblewski dependence) describes $P(n_-)$ in pp interactions up to 2000 GeV/c. In the same figure are presented the previously obtained results on $D_-=f(\langle n_-\rangle)$ for inelastic ^{12}C–A interactions (T(0,0) trigger in our designations). The data are given with statistical errors. The sources of systematic errors have been analyzed, and, according to our estimates, they do not exceed a few per cent.

One can see from Fig.1 that in CC the dependence of D_- on $\langle n_-\rangle$ is quite different in character as compared both to inelastic nucleus-nucleus and elementary interactions. We have already noted this effect in paper /3/, where the results are presented of a preliminary analysis of the data obtained.

The obtained values of $\eta=D_-^2/\langle n_-\rangle$, which characterize a relative width of $P(n_-)$ (for the Poisson distribution $\eta=1$), are plotted in Fig.2 in coordinates η vs A_t for all the "central" trigger modes which had sufficient statistics (see also Fig.3).

Proceeding from the data in Fig.2, we would thus formulate our result as follows: strengthening the CC selection criteria

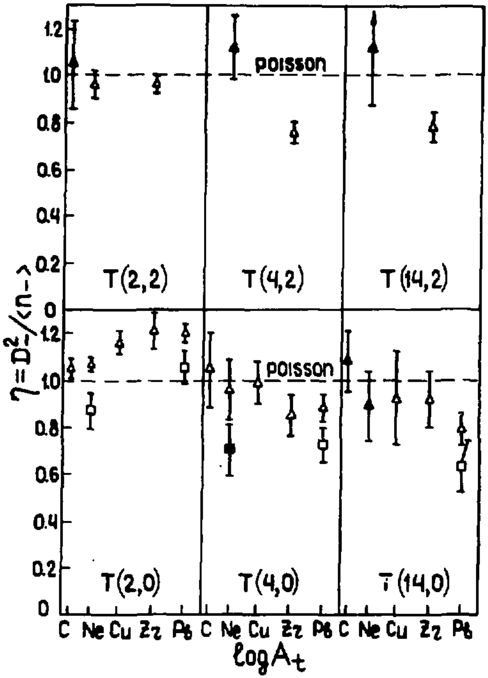

Fig.2. The relative width $\eta = (\langle n^2\rangle - \langle n\rangle^2)/\langle n\rangle$ in central $^{12}C+A(\Delta)$ and $^{16}O+A(\square)$ collisions versus A_t at various trigger modes $T(\theta_{ch}, \theta_n)$, where θ_{ch} and θ_n are the veto angles (in grades) for the emission of charged and neutral stripping particles, respectively. Black triangles correspond to the samples, where, for increasing the statistics, the veto condition for charged projectile fragments was slightly weakened: $N_f \leq 1$.

by including a neutron veto counter in the trigger system and/or by increasing the veto angle of charged projectile fragment emission to 4° results in decreasing the relative width of $P(n_-)$ up to η values of ≈ 0.8 for ^{12}C and ≈ 0.7 for ^{16}O. A further increase of the veto angle up to 14° leads practically to no changes of the η value. It is also seen from Fig.2 that the parameter η is systematically smaller for ^{16}O than for ^{12}C and that it comes to a plateau on light targets (C, Ne) earlier than on heavy ones.

Let us compare our results with predictions of some theoretical models.

The regularity $D^2_- \approx \langle n\rangle$ is explained in natural way in models of independent interaction of projectile-nucleus nucleons with target-nucleus ones [4].

The authors of paper [5] show that for a wide class of thermodynamic models the Poisson multiplicity distribution is expected for fixed-impact-parameter collisions. This result has been obtained neglecting the correlated production of two or more π^--mesons. It is

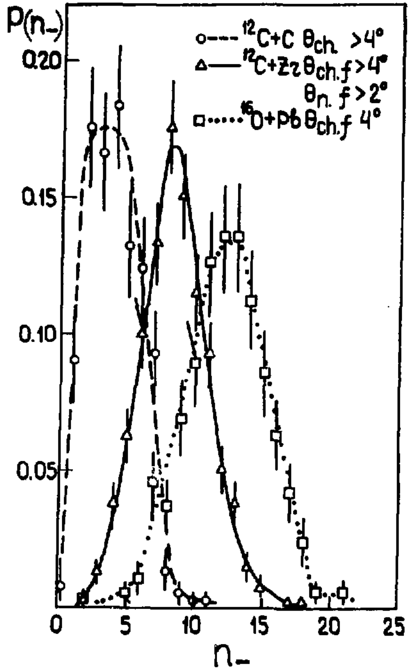

Fig.3. Multiplicity distributions P(n_) of π^--mesons produced in $^{12}C+C$ (o), $^{16}O+Pb$ (□) (trigger mode T(4,0)) and $^{12}C + Zr$ (Δ) (T(4,2)) (on the trigger designations see the text). The curves are drawn to guide the eye.

not clear whether the observed deviation of the P(n_) from the Poisson distribution is enough for claiming the contradiction with the named class of models.

A model of central collisions of relativistic nuclei, based on the idea of collective interaction, is considered in /6/. The results of calculation of mean multiplicities in CC, presented in this paper, agree with our data rather well. But this model suggests qualitatively similar characteristics of pion multiple production in CC and in elementary acts, while the above experimental data demonstrate the regularity of D(<n_>) behaviour which is different in principle.

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