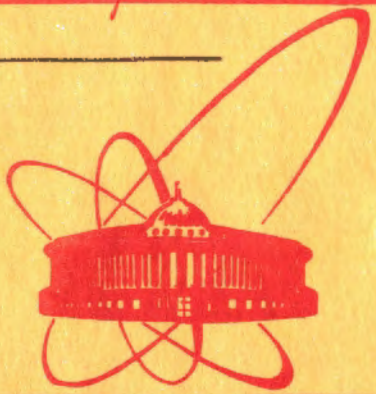

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CHARGED MULTIPLICITY DISTRIBUTIONS IN $\bar{n}p$ INTERACTIONS AT 6 GeV/c

Alma-Ata - Dubna - Moscow - Prague - Serpukhov -
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Батюня Б.В. и др.

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Распределения по множественности заряженных частиц в $\bar{n}p$-взаимодействиях при импульсе 6.0 ГэВ/с

В настоящей работе были определены неупругие топологические сечения $\bar{n}p$-взаимодействий при импульсе 6.0 ГэВ/с из $\bar{d}p$-взаимодействий с идентифицированным антипротоном-спектатором при 12 ГэВ/с. Экспериментальный материал был получен при экспозиции 2-метровой водородной камеры ОИЯИ "Людмила" на ускорителе в Серпухове. Средняя множественность заряженных частиц $\langle n \rangle$ и отношение средней множественности к дисперсии $\langle n \rangle / D$ для $\bar{n}p$-взаимодействий были найдены равными $3{,}32 \pm 0{,}13$ и $1{,}86 \pm 0{,}16$. Полученные результаты сравниваются с данными $\bar{p}n$-, $\bar{p}p$- и pp-экспериментов.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1980

Batyunya B.V. et al.

E1-80-164

Charged Multiplicity Distributions in $\bar{n}p$ Interactions at 6 GeV/c

Inelastic topological $\bar{n}p$ cross sections at 6 GeV/c have been determined from 12 GeV/c $\bar{d}p$ data with identified antiproton spectator. The data were obtained in an exposure of the JINR 2 m hydrogen bubble chamber Ludmila at the Serpukhov accelerator. In $\bar{n}p$ interactions average charged multiplicity $\langle n \rangle$ and its ratio to dispersion, $\langle n \rangle / D$, were found to be 3.32 ± 0.13 and 1.86 ± 0.16, respectively. Comparison with $\bar{p}n$, $\bar{p}p$ and pp data was made.

The investigation has been performed at the Laboratory of High Energies, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1980

The first results are presented on antineutron-proton interactions at 6 GeV/c based on a study of the charged multiplicity distribution in antideuteron-proton collisions at 12 GeV/c. Up to date the total cross sections of $\bar{d}p$ interactions have been measured only at 13.3 GeV/c [1]. The presented investigation is based on approximately 40 000 pictures from an exposure of the 2 m HBC Ludmila to a 12 GeV/c RF-separated antideuteron beam at the Serpukhov accelerator with a momentum spread of $\pm$ 1%. The intensity of the antideuteron beam was equal to ~ 0.85 $\bar{d}$/picture and the total hadron background (π^-, K^-, $\bar{p}$) was equal to $\sim$ 50%.

The films were scanned twice. Discrepancies between the two scans were resolved in a third scan. The amount of $\bar{n}p$ interactions was extracted from $\bar{d}p$ events having a forward antiproton spectator.

The selection was made on scanning table providing the scattering angle of the forward antiproton spectator does not exceed $\pm$ 2°.

In order to estimate the amount of negative particles, which resemble the antiproton spectator and are not it, $\bar{p}p$ interactions at 22.4 GeV/c (data are described, e.g., in ref. [2]) were used. Among the geometrically reconstructed $\bar{p}p$ interactions only $\sim$ 3% of events were found to have a track resembling an antiproton spectator from $\bar{d}p$ interactions.

Therefore we conclude that the contamination of $\bar{p}p$ interactions in $\bar{d}p$ reactions does not exceed 3%. The total amount of $\bar{n}p$ interactions was determined using the obtained scanning efficiency 0.98 ± 0.03. The $\bar{n}p$ data presented here (topological cross sections, normalized multiplicity momenta, correlation parameter and their errors) were obtained using the system of programs described in ref. [3].

Analogously to the method used in the 22.4 GeV/c $\bar{p}p$ experiment [2], the scanning loss, σ_{loss}, of events with 2 prongs was estimated to be $\sigma_{loss} = 3.9 \pm 0.4$ mb for $\bar{n}p$ interactions which corresponds to a minimum effective proton range of $\sim$ 1,5 cm.

The $\bar{n}p$ data of this experiment were normalized to the total and elastic cross sections from counter experiments: $\sigma_{tot}(\bar{n}p) = 59.0 \pm 3.0$ mb (1) and $\sigma_{el}(\bar{n}p) = \sigma_{el}(\bar{p}n) = 16.5 \pm 2.4$ mb [4].

The number of interactions as a function of charged multiplicity and the corresponding topological cross sections, σ_n, are given in table 1 with errors that include the statistical and correction errors. The inelastic one-prong cross section, presented in table 1, was corrected for the scanning losses. About 500 events had secondary interactions on the possible antiproton spectator track close to the primary vertex. These events were assigned to an uncountable category and were excluded from the data in table 1. Some other corrections were also made, for example, ~1% of even prong $\bar{n}p$ events were shifted to the next higher class of topology. Obvious Dalitz pairs were eliminated at the scanning level.

In fig.1 we compare our $\bar{n}p$ topological cross sections, σ_n, with the available $\bar{p}n$ data in an incident momentum region of 5-15 GeV/c [5]. One can see from this figure that these σ_n are in reasonable agreement with the $\bar{p}n$ data. Figure 2 presents σ_n as a function of multiplicity n. For comparison the topological cross sections from $\bar{p}n$ interactions at 5.55 GeV/c [5] are shown. The $\bar{p}n$ data weakly differ from the hand-drawn curve connecting our pointe. It should be noted that the $\bar{p}n$ cross sections at 5.55 GeV/c are normalized to $\sigma_{tot}(\bar{p}n) = 55 \pm 3$ mb [4].

Table 2 gives the average charged multiplicity $\langle n \rangle$, the dispersion $D = [\langle n^2 \rangle - \langle n \rangle^2]^{1/2}$, the ratio $\langle n \rangle / D$, the higher multiplicity normalized momenta $C_q = \langle n^q \rangle / \langle n \rangle^q$ ($q = 2,3,4$) and the Mueller correlation parameter $f_2^- = \langle n/2(n/2-1) \rangle - \langle n/2 \rangle^2$ for inelastic events. In fig.3 we compare our value for $\langle n \rangle$ with the average multiplicities for $\bar{p}n$, $\bar{p}p$ and pp interactions at different incident beam momenta P_{lab}.

The dispersion D determined in this experiment, plotted as a function of $\langle n \rangle$, is compared with the $\bar{p}n$ and $\bar{p}p$ data in fig.4. We observe that for a given $\langle n \rangle$ the dispersion of the $\bar{n}p$ charged multiplicity is close to the $\bar{p}p$ one.

The ratios $\langle n \rangle / D$ and $C_q = \langle n^q \rangle / \langle n \rangle^q$ ($q = 2,3,4$) are compared with the $\bar{p}n$ data at different P_{lab} in fig.5(a,b). One can see from this plot that the values of C_q and $\langle n \rangle / D$ depend on P_{lab} only weakly as expected if the data obey the early KNO scaling [6]. In fact, plotting $\langle n \rangle \sigma_n / \sigma_{in}$ versus $n/\langle n \rangle$ in fig.6, we can see a concentration of our and $\bar{p}n$ points around the universal KNO curves. Note that the deviation of high multiplicity $\bar{p}n$ points from the fitted pp [7] and $\bar{p}p$ [8] curves can be explained as a consequence of the empirical Wroblewski-Malhotra rule [9,10].

The authors thank the staff of the beam-line no.9 of the Serpukhov accelerator and of the 2 m HBC Ludmila and the technicians and operators of all laboratories for excellent work.

Table 1

Number of events and topological cross sections for the $\bar{n}p$ -reaction at 6 GeV/c.

Multiplicity	Number of weighted events	Topological cross sections (mb) (normalized to 59 ± 3 mb)
1	1445 ± 51	26,61 ± 1,70
1 inelastic		10,11 ± 2,90
3	1210 ± 41	19,05 ± 1,23
5	640 ± 30	10,07 ± 0,74
7	186 ± 16	2,93 ± 0,31
9	20 ± 6	0,32 ± 0,11
11	1 ± 1	0,016 ± 0,016
Total	3502 ± 75	59,0 ± 3,0
Total inelastic		42,5 ± 3,8

Table 2

Statistical moments for inelastic events calculated from the charged multiplicities obtained in $\bar{n}p$ interactions at 6 GeV/c.

$\langle n \rangle$	D	$\langle n \rangle / D$	C_2	C_3	C_4	f_2^-
3.32±0.13	1.79±0.15	1.86±0.16	1.29±0.05	1.95±0.19	3.32±0.59	-0.36±0.14

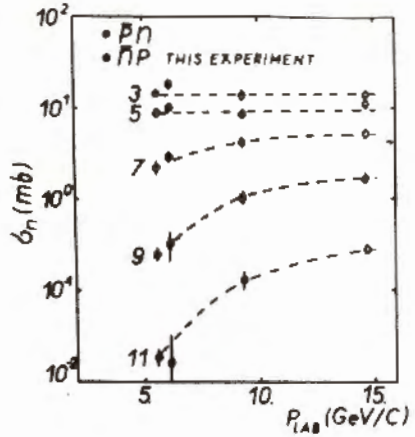

Fig.1. Comparison of the topological $\bar{n}p$ cross sections at 6 GeV/c with available $\bar{p}n$ ones in an incident momentum region of 5 - 15 GeV/c as a function of incident momentum P_{lab} . The dashed lines are drawn to guide the eye.

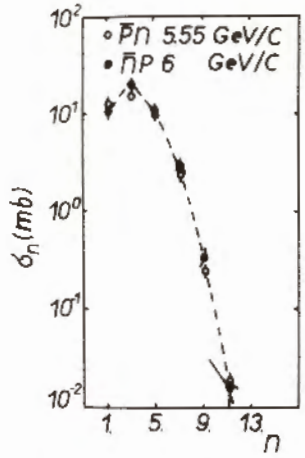

Fig.2. Comparison of the $\bar{n}p$ topological cross sections plotted versus multiplicity n with the $\bar{p}n$ data at 5.55 GeV/c. The dashed line is drawn to guide the eye.

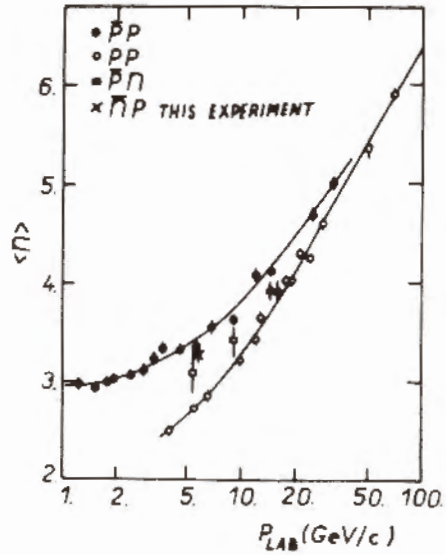

Fig.3. Average multiplicity for $\bar{p}p$, pp, $\bar{p}n$ and $\bar{n}p$ interactions as a function of incident momentum P_{lab} . The full curves are drawn to guide the eye.

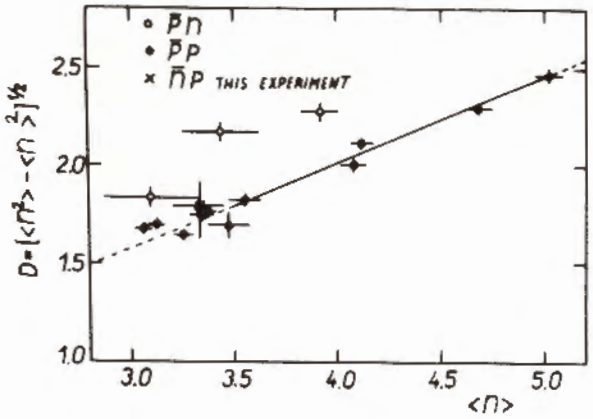

Fig.4. Dispersion D of the charged multiplicity versus its average $\langle n \rangle$ for our results and $\bar{p}n$ and $\bar{p}p$ interactions. The straight line is obtained by fitting the $\bar{p}p$ data in the $\langle n \rangle > 3.5$ region.

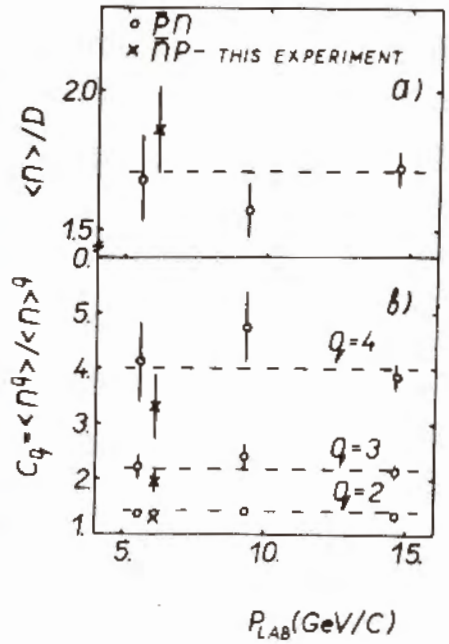

Fig.5. Dependence a) of the ratio $\langle n \rangle / D$ and b) of $C_q = \langle n^q \rangle / \langle n \rangle^q$ on incident momentum compared with analogous $\bar{p}n$ data.

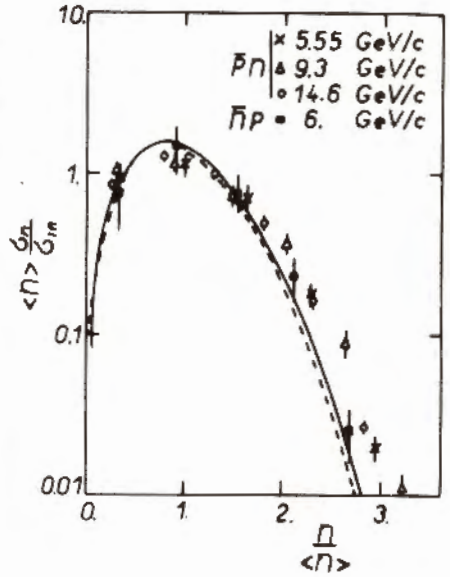

Fig.6. Scaling quantity $\langle n \rangle \sigma_n / \sigma_{in}$ versus $n/\langle n \rangle$ for the $\bar{n}p$ data in this experiment compared to other $\bar{p}n$ data. The curves are the fit of Slattery [7] to pp data (full line) and of Dao et al. [8] to $\bar{p}p$ data (dashed line).

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