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**ANALYSIS
OF TOPOLOGICAL CROSS SECTIONS
IN $\bar{p}p$ INTERACTIONS AT 22.4 GEV/C**

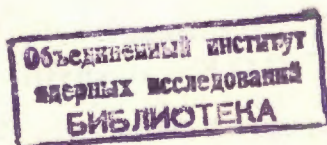
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**ANALYSIS
OF TOPOLOGICAL CROSS SECTIONS
IN $\bar{p}p$ INTERACTIONS AT 22.4 GEV/C ***

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In this paper we present the first results on the investigation of $\bar{p}p$ interactions using the 2 m HBC "Ludmila" exposed to 22.4 GeV/c antiproton beam at the Serpukhov accelerator.

The antiproton beam was separated out of secondary particles by RF cavities. The momentum spread of the beam was of 0.25%^{/1,2,3/}. The estimation of π^-/K^- contamination obtained from the number of interactions found with the RF separators switched off gave an upper limit of 2%. A sample of ~ 20000 pictures was scanned twice. Taking into account a scanning efficiency of $0.99 \pm \pm \begin{matrix} 0.01 \\ 0.05 \end{matrix}$ we found 11558 events.

A part of the two-prong sample was analysed in order to estimate the loss of elastic events. Having investigated the momentum transfer and the range distributions of short stopping protons we estimated the loss to be $\sigma_{\text{loss}} = 2.5 \pm 0.5$ mb. The error of this number is incorporated into all the following calculations. For the total and elastic cross sections we used the values $\sigma_{\text{tot}} = 48.0 \pm 0.5$ mb and $\sigma_{\text{el}} = 8.9 \pm 0.2$ mb from counter experiments^{/4,5/}. The value σ_{loss} corresponds to losses of events with an effective proton range of 1.5 cm. The total cross section thus obtained from the number of primary tracks entering the fiducial region and the number of interactions is 47.2 ± 1.5 mb. (the length of the fiducial region is 107.8 ± 0.1 cm and hydrogen density was taken to be 0.062 ± 0.001 g/cm⁻³). The difference (48.0 ± 0.5) mb - (47.2 ± 1.5) mb may correspond to a muon contamination $\sim 2\%$, which is in accordance with the number of fast δ -electrons found during the scanning. Thus, in a further analysis we normalized our data to the cross sections from the counter experiments given above.

In Table I we present the number of events for different topologies and the corresponding cross sections. The two-prong cross section was corrected for the losses, and the inelastic cross section is given as well.

Table I
Number of events and topological cross sections

Number of prongs	Number of events	Cross section (mb) (normalized to 48.0 ± 0.5 mb)
0	166 ± 17	0.65 ± 0.07
2	3863 ± 71	17.75 ± 0.80
2 inel.		8.81 ± 0.90
4	3599 ± 64	14.17 ± 0.32
6	2410 ± 52	9.45 ± 0.24
8	1080 ± 35	4.25 ± 0.15
10	361 ± 20	1.42 ± 0.08
12	62 ± 8	0.24 ± 0.03
14	16 ± 4	0.06 ± 0.02
16	1 ± 1	0.004 ± 0.004
Total	11558 ± 117	48.0 ± 0.5
Total inelas.		39.1 ± 0.8

A comparison with results from other experiments^{16/} is done in fig. 1.

For the inelastic events we have calculated average charged multiplicity and dispersion. The higher multiplicity normalized momenta ($c = \langle n^q \rangle / \langle n \rangle^q$) and the correlation function ($f_2^- = \langle n_{ch} / 2(n_{ch} / 2 - 1) \rangle - \langle n_{ch} / 2 \rangle^2$) are also given (see Table II). The energy dependence of the charged multiplicity is displayed and compared with the data from pp interactions in fig. 2. For $p_{lab} = 5 \text{ GeV}/c - 32 \text{ GeV}/c$ ^{19/} we have fitted the experimental points by

$$\langle n \rangle = a + b \ln(s/s_0),$$

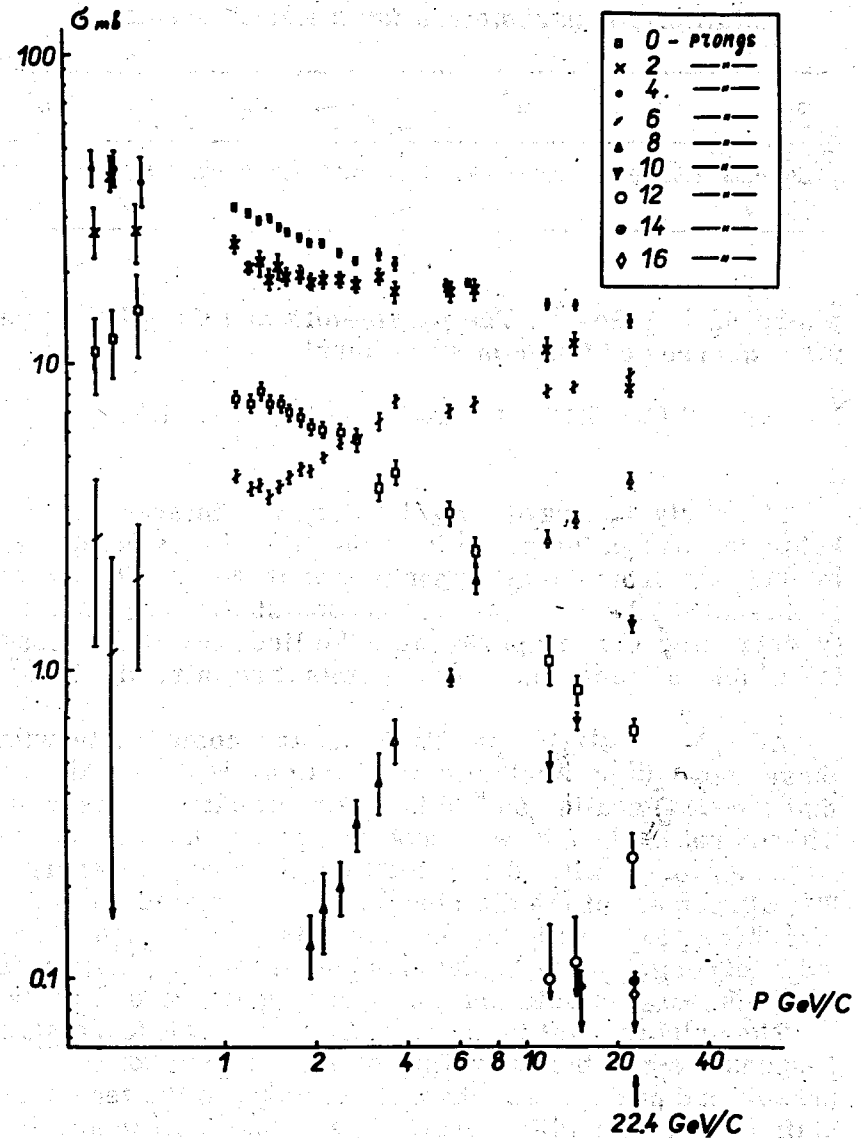


Fig. 1. Topological cross sections as a function of p_{lab}

Table II

Multiplicity parameters for inelastic events

n	D	n/D	c_2	c_3	c_4	f_2^-
4.69 ± 0.05	2.30 ± 0.06	2.04 ± 0.05	1.24 ± 0.01	1.80 ± 0.03	2.94 ± 0.08	-1.02 ± 0.06

where $s_0 = 1 \text{ GeV}^2$. The parameters and the χ^2 value for 5 degrees of freedom were found

$$a = 0.69 \pm 0.19, \quad b = 1.05 \pm 0.05, \quad \chi^2 = 1.7.$$

The early scaling of $\langle n \rangle / D$ for $\bar{p}p$ interactions^{/7/} holds for our value given in Table II, and it is compared to the data from other experiments in fig. 3. The curve representing the pp reactions is consistent with a smoothly decreasing curve approaching the line $\langle n \rangle / D = 2$, close to which all the $\bar{p}p$ data points are already lying.

As c_q 's given in Table II are comparable with those found in pp inelastic interactions^{/8/}, we can say that the KNO scaling should hold for our data^{/6/} as well. Therefore in fig. 4 we have compared the pp curve $\Psi(n/\langle n \rangle)$ with the points obtained at our energy. The agreement of the distribution of normalized multiplicity $\Psi(n/\langle n \rangle)$ with the pp curve is good enough. However, experiments at higher energies and topological cross sections for annihilation reactions would be desirable.

The authors want to express their gratitude to the staff responsible for the operation of the accelerator at Serpukhov and of the beam channel no. 9 and to the technical staff of the "Ludmila" HBC. One of us (S.L.) would like to thank the JINR for the hospitality during her stay at Dubna.

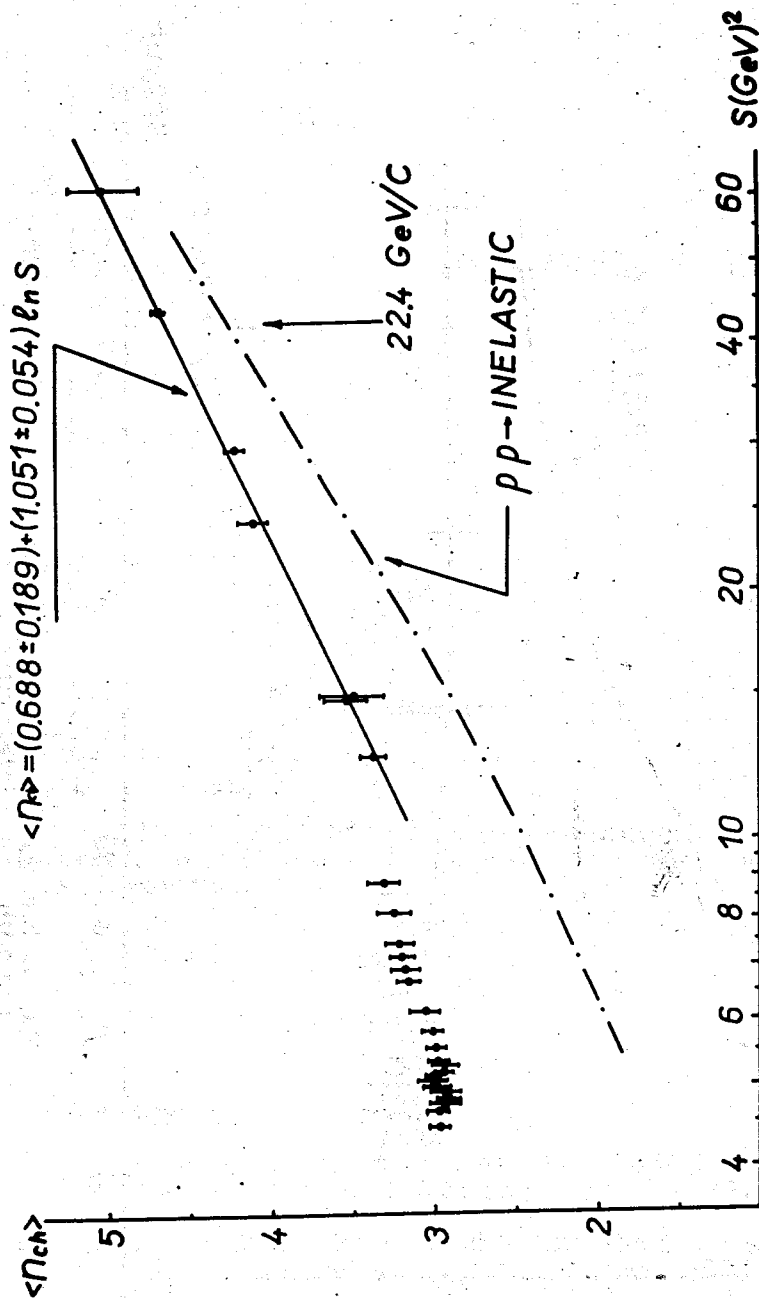


Fig. 2. Average charged multiplicity as a function of centre of mass energy squared. The lines correspond to pp data and to fitted $\bar{p}p$ data with $p_{\text{lab}} > 5 \text{ GeV}/c$.

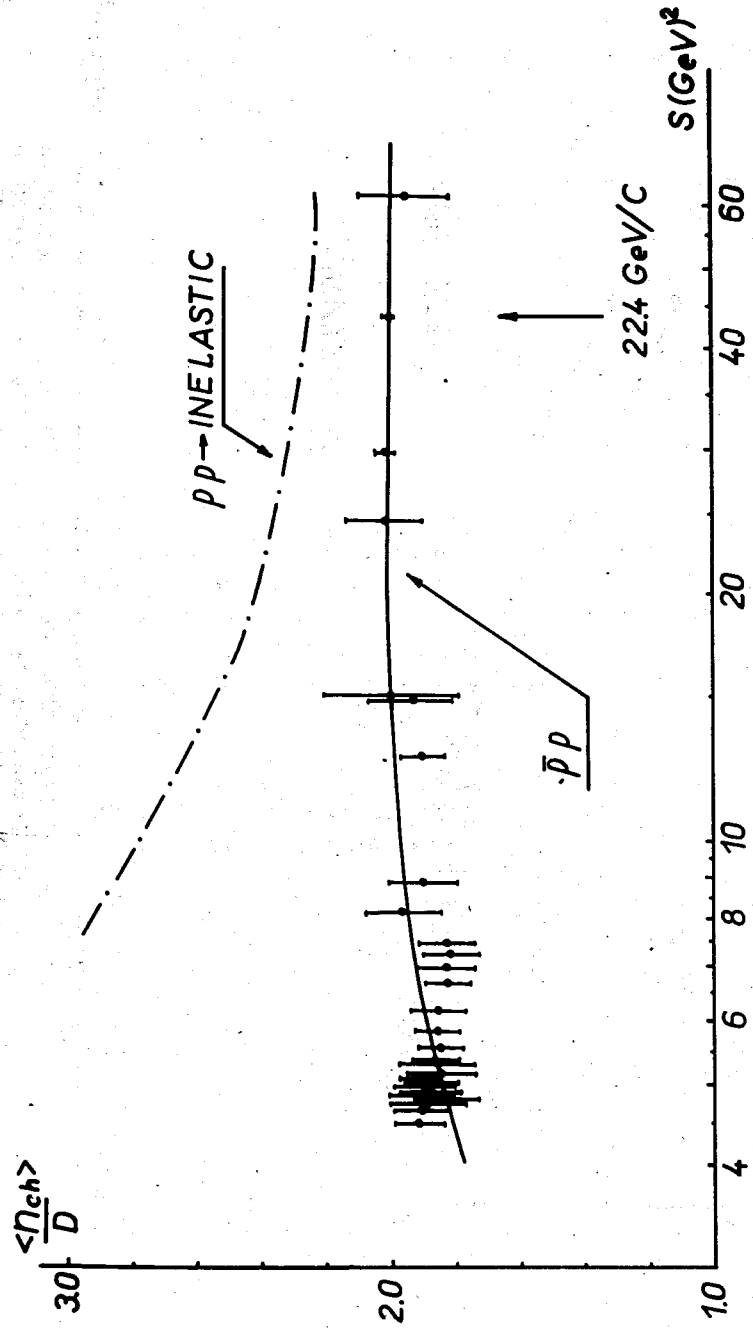


Fig. 3. Energy dependence of the ratio $\langle n_{ch} \rangle / D$ compared with pp interactions.

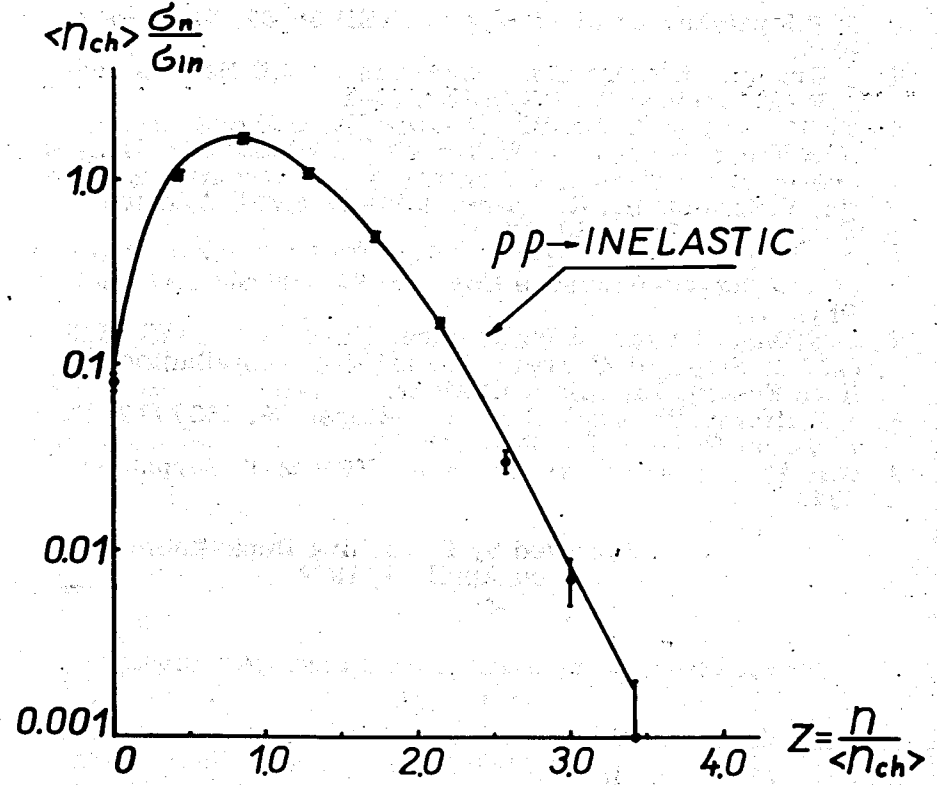


Fig. 4. Distribution of normalized multiplicities for $\bar{p}p$ interactions at 22.4 GeV/c compared with a fit to pp data at high energies ^{8/}.

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Анализ топологических сечений $\bar{p}p$ -взаимодействий
при 22,4 ГэВ/с

Проведен анализ распределения по множественности для 11558 событий $\bar{p}p$ -взаимодействий при 22,4 ГэВ/с. Среднее значение множественности заряженных частиц для неупругих процессов оказалось равным $4,69 \pm 0,05$ и $\langle n \rangle / D = 2,04 \pm 0,05$. Исследовался ранний KNO-скейлинг нормированных топологических сечений.

Препринт Объединенного института ядерных исследований.
Дубна, 1974

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Analysis of Topological Cross Sections in
 $\bar{p}p$ Interactions at 22.4 GeV/c

The multiplicity distribution for 11558 events in $\bar{p}p$ interactions at 22.4 GeV/c was analysed. The average charged multiplicity $\langle n_{ch} \rangle$ for inelastic events was found to be 4.69 ± 0.05 and $\langle n_{ch} \rangle / D = 2.04 \pm 0.05$. The early KNO scaling of normalized topological cross sections has been tested.

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