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AN INVESTIGATION OF MULTIPLICITY DISTRIBUTIONS IN DIFFERENT PSEUDORAPIDITY INTERVALS IN $\bar{p}p$ REACTIONS AT A C.M.S. ENERGY OF 540 GeV

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ABSTRACT

Multiplicity distributions of charged particles for inelastic, non single-diffractive events in proton-antiproton collisions at a centre of mass energy of 540 GeV are presented for various pseudorapidity ($\Delta\eta$) intervals. The widths of the multiplicity distributions, scaled to their means, increase as $\Delta\eta$ is made smaller, and the deviation from a Poisson distribution becomes progressively more pronounced. It is found that the data are remarkably well described by a negative binomial distribution, when the centre of the interval coincides with $\eta = 0$ in the c.m.s. and reasonably well also for intervals with centres somewhat displaced from $\eta = 0$. The parameters of the distributions vary smoothly with the size and position of the acceptance interval.

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1. INTRODUCTION

The experimental study of charged particle multiplicity distributions in high energy inelastic collisions has been the subject of many investigations [1]. Such distributions are sometimes described in terms of the scaled variables $\langle n \rangle P_n$ and $n/\langle n \rangle$ (where P_n is the probability for an event with n charged prongs and $\langle n \rangle$ is the average number of charged particles). KNO-scaling [2] implies a universal form, $\langle n \rangle P_n = \psi(z=n/\langle n \rangle)$, for the multiplicity distribution at sufficiently high energy. Thus there would be only one energy dependent parameter, the average multiplicity $\langle n \rangle$. Approximate KNO-scaling was found to hold, e.g. for inelastic, non single--diffractive proton-proton reactions from c.m. energy $\sqrt{s} \approx 10$ GeV up to the maximum ISR energies ($\sqrt{s}$=63GeV) [3]. However, at the CERN collider, at a c.m.s energy of 540 GeV, our collaboration has reported violation of KNO-scaling [4] in the inelastic, non single-diffractive data, in which an increased probability for large multiplicities was observed. On the other hand, approximate KNO-scaling was reported to hold up to the same energy for a limited central region of phase space by UA1 [5] and UA5 [4]. However, as shown in this paper the shape of the multiplicity distribution depends on the size of the acceptance interval. Furthermore the shape also changes when the sample is truncated by imposing the condition that at least one charged particle is observed in the region considered, as has been done by some investigators [4,5].

Several theoretical models like the dual parton model [6], models for soft QCD bremsstrahlung [7], a model involving production of independent "fireballs" [8], and the quantum statistical or chaotic source model [9] have predicted that KNO-scaling would be broken. Some models predict narrower distributions at increased energy but the dual parton model and the "fireball" model predict wider distributions, in qualitative agreement with observations of the UA5 collaboration [4].

In this paper we report on a systematic study of the shapes of the multiplicity distributions in different intervals of pseudorapidity, $|\eta| < \eta_c$ ($\eta = -\ln\tan\theta/2$ where θ is the c.m.s. emission angle). We have also studied the distributions in different non-central intervals. The data used are non single-diffractive events obtained at the CERN SPS collider at 540 GeV c.m.s. energy. The procedures for correcting and analysing the data are given in section 2. Corrected multiplicity distributions are given in section 3.1 for the case with η-intervals centred at $\eta = 0$ in the c.m. system. Parametrizations of the distributions in the same η-intervals are presented in section 3.2. Results for multiplicity distributions in η-intervals with centres displaced from $\eta_{c.m.s.} = 0$ are presented in section 3.3.

Remarkably good fits to the data are obtained with a set of probability distributions, one for each choice η_c, using:

$$P(n;<n>,k) = \begin{bmatrix} n+k-1 \\ k-1 \end{bmatrix} \left[\frac{<n>/k}{1+<n>/k}\right]^n \frac{1}{(1+<n>/k)^k} \qquad (1)$$

This distribution is known as the negative binomial distribution in the variable n, where the first parameter <n> determines the position, being equal to the expected average of n, and k influences the shape of the distribution. In physics this distribution is known as the generalized Bose-Einstein distribution when k is an integer [10,11]. It becomes a Poisson distribution in the limit $k \to \infty$ and a simple Bose-Einstein (i.e geometric) distribution for k=1. Such distributions have applications in many areas of science.

One example of the appearance of the negative binomial distribution in physics is photon counting in quantum optics. The number n of identical bosons, in one phase space cell, with mean <n> follows a Bose-Einstein distribution (negative binomial with k=1) [11]. This was observed in photon counting experiments in 1965 [12] with a He-Ne laser operated well below threshold. High above threshold the laser light fluctuations approach a Poisson distribution. The number of identical photons from k independent sources of equal strength <n>/k fluctuates according to the generalized Bose-Einstein distribution with the parameters <n> and k (integer) [10]. Under certain conditions photon counting from a thermal source ,is expected to follow a negative binomial distribution with k not necessarily an integer [13].

In particle physics this kind of distribution was applied many years ago [14] and its usefulness was emphasized by several authors [15,16] and was recently revived [17]. When the parameter k has been taken as an integer, the interpretation was often similar to that used in photon counting i.e. equal to the number of independent phase space cells. We emphasize that in this paper we do not restrict k to be an integer, for which case the binomial coefficient in (1) is given by k(k+1).....(k+n-1)/n!

Finally, we mention that the asymptotic form of (1) (when $\langle n \rangle$ is large) can be written as a gamma distribution in the scaled variable $z = n/\langle n \rangle$ [18], namely

$$\langle n \rangle P(n;k) = \frac{k^k}{\Gamma(k)} z^{k-1} e^{-kz} \qquad (2)$$

For KNO-scaling to hold in this approximation k has to be energy independent. Application of this form (with k=2) to multiplicity distributions at high energy has been made [8].

2. EXPERIMENTAL PROCEDURE

2.1 Detector and data

The UA5 detector consists of two large streamer chambers, placed above and below the SPS beam pipe, respectively. Each chamber is viewed by a set of three cameras and tracks are reconstructed in space from point measurements on the film. The geometrical acceptance of the detector is about 95% in the plateau region $|\eta| < 3$ where the particle density is high, falling to zero at $|\eta| > 5$ where the number of produced particles is low. The large acceptance makes the results for the multiplicity distributions reliable since the corrections are small. The apparatus was equipped with a beam pipe of beryllium in order to minimize electromagnetic interactions.

The trigger system was based on two large scintillation counter hodoscopes placed at each end of the streamer chambers. They cover a pseudorapidity range $2 < |\eta| < 5.6$. For the sample of events used here the trigger required at least one hit in each arm. This trigger rejected essentially all elastic and most single diffractive events but accepted about 95% of non single-diffractive events as determined by Monte Carlo simulations. The detector and the analysis procedures are described in more detail in the references [19,20].

The data sample used in this analysis consists of 7344 non single--diffractive events containing 168656 observed primary tracks and was taken during the run in 1982 at the CERN SPS collider. The analysis was performed for different cuts in the c.m.s pseudorapidity (η_c) such that only particles emitted in the interval $-\eta_c<\eta<\eta_c$ were counted. This study was supplemented by another one for which the centre of the acceptance interval was displaced from $\eta = 0.$ in the c.m.s. No further requirement, such as observing at least one track in the accepted region, was made.

2.2 Analysis method

Differences between observed and true multiplicities are caused by limitations in the geometrical acceptance, and by contamination of primary tracks by secondaries, e.g. charged particles from strange particle decays and from hadronic interactions and electron positron pairs from photons converting in the beam pipe. These effects were corrected for using a Monte Carlo simulation.

The event generator used in the Monte Carlo was adjusted to reproduce the observed features of real events. Particles were produced in clusters with a cluster size of two charged particles on average [21] and the yield of strange particles [22] and photons [23] as well as the shape of the rapidity distribution were reproduced as a function of charged multiplicity [19]. The generated tracks were followed through the detector, allowing interactions and scattering to take place. The Monte Carlo events were then treated in the same way as the measured events.

The trigger efficiency was determined in the Monte Carlo simulations using non single-diffractive events. For events with high multiplicity the efficiency is 100%. For events with a few charged particles the efficiency varies with the number of particles and with the pseudorapidity range considered and in some cases it is as low as 30 %. There may be systematic errors at the lowest multiplicities (n = 0,1,2) since the corrections for trigger efficiency are sensitive to the input model. The trigger efficiency ε_n was determined in each pseudorapidity interval for each true multiplicity n.

The Monte Carlo simulations were used to produce a set of probabilities P_{mn} that a true n prong event is observed as an m prong event. If O_m is the number of events observed to have m tracks and T_n is the true number of n-prong events we have:

$$O_m = \sum_n P_{mn}\, T_n\, \varepsilon_n \qquad (m = 0,1,2\ldots) \qquad (3)$$

The matrix elements P_{mn}, depending on the η-interval considered and its position, represent the knowledge of the detector and the measurement procedure.

A. Corrected multiplicity distribution

When correcting a multiplicity distribution in full phase space one gets an overdetermined system of equations, since the true number of charged particles must be even due to charge conservation.

When considering a limited pseudorapitity range the true number of charged particles can be both odd and even and eq. 3 is no longer an overdetermined system. It is underdetermined or at most just determined. In the latter case eq. 3 could in principle be solved by calculating the inverse matrix. This method, however, gives unstable results. We prefer an iterative method to find the true multiplicity. Also in this case the solution becomes stable for $\eta_c > 1$ only after reducing the number of unknowns by grouping into bins of 2 or 3 particles.

For the corrected distributions neighbouring points are highly correlated. Therefore the best way to fit a model to the data is to use the method described below.

B. Fitting the observed distribution

For the true multiplicity distribution T_n we assume a negative binomial distribution according to eq. 1, with two free parameters <n> and k, and we emphasize again that we do not assume the parameter k to be an integer.

The two parameters are varied until the best fit to the observed distribution O_m is obtained, using minimum X^2 as a criterion. Here

$$\chi^2 = \sum_m \frac{(O_m - N\sum P_{mn}\varepsilon_n T_n)^2}{\sigma_m^2} \qquad (4)$$

where N is a factor which normalizes to the number of observed events. The statistical errors appearing in the weight factors σ_m^{-2} have two contributions: one from the finite numbers of observed events and one from the finite numbers of Monte Carlo generated events.

3. RESULTS

3.1 THE CORRECTED MULTIPLICITY DISTRIBUTIONS FOR η-INTERVALS CENTRED AT $\eta = 0$ IN THE C.M.S.

The corrected multiplicity distributions were determined for a set of central acceptance intervals defined by the pseudorapidity cut η_c from 0.5 to 5.0 in steps of 0.5 with a smaller interval added for which η_c is 0.2. Figure 1a shows some of the corrected multiplicity distributions. The errors shown are statistical only. Systematic errors, due to uncertainties in the precise assignment of charged particles to the primary vertex and due to uncertainties in trigger efficiency, are about as large as statistical ones for each data point, except for the lowest multiplicity events where they are somewhat larger for reasons discussed in the previous section.

The multiplicity distributions have different shapes in the different pseudorapidity intervals with relative fluctuations increasing with decreasing size of the interval. This is clearly seen when the distributions are plotted as a function of the variables $\langle n\rangle P_n$ versus $z = n/\langle n\rangle$ shown in fig 1b. In our sample of about 7000 events we observe fluctuations as large as $z = 8$ for $\eta_c = 0.5$ but only to $z = 4$ for $\eta_c = 5.0$.

The shape of the distributions is quantified by the moments. The C-moments, where $C_q = \langle n^q\rangle/\langle n\rangle^q$, are plotted in figure 2 and given in table 1. All moments increase as the η-interval is decreased. The changes are especially large for the smaller pseudorapidity intervals.

3.2 FITTING THE NEGATIVE BINOMIAL DISTRIBUTION TO DATA FOR η-INTERVALS CENTRED AT $\eta = 0$ IN THE C.M.S.

The negative binomial that is taken to represent the true multiplicity distribution is transformed by the matrix P. The transformed distribution is fitted to the uncorrected data using the method described in the previous section. This is repeated for the selected c.m.s. pseudorapidity intervals η_c=0.2 and from η_c=0.5 up to η_c=5.0 in steps of 0.5 . Examples of the resulting distributions are given in figure 1a together with the corrected distribution. The fact that the fits seem to be good is born out by the values of minimum X^2 given in table 2. Also given is $y = \sqrt{2X^2} - \sqrt{2DF - 1}$ (where DF is the number of degrees of freedom) which is expected to be approximately normally distributed with mean 0 and standard deviation 1 for large enough values of DF. The largest contribution to X^2 comes from the first two bins (n=0,1), the remaining X^2 never deviates from expectation by more than two standard deviations which is remarkably good, considering that X^2 as defined in (4) depends only on statistical errors and may be too large due to the presence of systematic errors. Since, as discussed in the previous section, systematic errors are expected to be larger for small multiplicities we do not claim that the large contribution to X^2 from to zero- and one-prong events is serious. We can conclude that the negative binomial distribution describes the data remarkably well. Also given in table 2 are the values of the parameters <n> and k. The parameter <n> grows smoothly with the size of pseudorapidity interval as expected from our corrected pseudorapidity distribution [19]. The parameter k increases almost linearly with the size of the pseudorapidity intervals as seen in figure 3a. In figure 3b the inverse of k is plotted. A Poisson distribution corresponds to $k^{-1}=0$. The figure shows that all distributions differ clearly from a Poisson, the more so the smaller the acceptance region. The other extreme, k=1, corresponds to the Bose-Einstein distribution which is expected for identical bosons from one phase space cell.

3.3 PSEUDORAPIDITY INTERVALS NOT CENTRED AROUND ZERO

All the results discussed in the previous sections concern pseudorapidity intervals centred at $\eta = 0$ in the c.m. system. Multiplicity distributions in limited pseudorapidity intervals with the centre shifted from $\eta = 0$ have also been studied for the three smallest intervals $\Delta\eta = 0.4$, 1 and 2 with the centres positioned at $|\eta| = 0.5, 1, \ldots 3$. Moments of the corrected distributions are given in table 3. Negative binomial distributions fitted to these non-central data give acceptable X^2 for $\Delta\eta = 0.4$ for all positions of the centre in the investigated range $|\eta| < 3$. For $\Delta\eta = 1$ and $\Delta\eta = 2$, the fit is acceptable judged from X^2, if the interval is centred in $|\eta| < 2$. The parameter <n> is again in agreement with the known pseudorapidity density distribution [19] and the other parameter k is given in table 4 and fig. 4. This parameter is minimum for intervals at $\eta = 0$ and increases slowly with the position of the centre.

4. DISCUSSION AND CONCLUSIONS

In our systematic study of inelastic, non single-diffractive reactions at the CERN SPS collider with 540 GeV c.m.s. energy a new regularity has been found for the multiplicity distributions in limited intervals of pseudorapidity. In all cases the data are very well represented by a negative binomial distribution, which deviates progressively more from a Poisson distribution when the pseudorapidity interval is made smaller. Thus the correlation between charged particles becomes stronger at smaller pseudorapidity intervals. The parameter $\langle n \rangle$, i.e. the average charged particle multiplicity, increases with the size of the pseudorapidity interval in agreement with the known shape of the density distribution $dn/d\eta$ vs η [19]. The other parameter, k, increases almost linearly with the interval size η_c, from an extrapolated value of 1.5 at $\eta_c = 0$ to 3.2 at $\eta_c = 5.0$.

An interpretation of the integer values of the parameter k as the number of independent phase space cells, as in photon counting, may seem supported by the fact that k increases when the pseudorapidity interval is made larger. Several difficulties remain unexplained, however. Firstly, the best fits require k to deviate from integer values. Also since at least two kinds of indentical bosons (π^+ and π^-) are involved one would expect $k \geq 2$, but in fact k approaches 1.5 for small η-intervals. Our detector has no magnetic field, so we cannot study each charge separately, which obviously would be of interest. Another difficulty with the interpretation is that the parameter k decreases with energy, whereas one would expect it to increase. From published data of inelastic, non single-diffractive pp and $\bar{p}p$ events we find that k^{-1} is an approximately linear function of ln s [24]. An increase of k^{-1} (denoted g^2) was reported earlier [16] at lower energies for several different inelastic reactions (diffractive included).

The negative binomial distribution implies strong correlated emission of particles, as is seen from its non-zero f_2-parameter, $f_2 = \langle n(n-1) \rangle - \langle n \rangle^2 = \langle n \rangle^2/k$. Besides the stimulated emission of bosons inherent in the above-mentioned Bose-Einstein distribution, there are other mechanisms explicitly incorporating correlated emission of particles, in particular those involving the production and decay of resonances and clusters. Our collaboration has reported observations based on a study of forward-backward multiplicity correlations [21] and a study of short range two-particle correlations [25], which indicate an average cluster size of about two charged particles.

Finally, we mention the possibility that the agreement with negative binomial distributions is only approximate. Arguments, based on an analysis of forward-backward multiplicity correlations, have been advanced that the parent cluster multiplicity itself follows a negative binomial distribution [26]. The distribution of particle multiplicities will then depend on the parameters of this parent distribution and on the type of cluster size distribution. A separate Monte Carlo study shows that this case cannot be excluded, since the resulting distribution for particles may follow a negative binomial distribution sufficiently closely, not showing significant differences (except at n=0,1) in samples of less than 10000 events.

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TABLE CAPTIONS

Table 1. The moments of the corrected multiplicity distributions in a central interval $|\eta| < \eta_c$. The errors given are statistical. The systematic errors are about equal within a factor of 0.5 - 3. $D_2=\sqrt{<(n-<n>)^2>}$ and the C-moments are defined by $C_q=<n^q>/<n>^q$. It should be noted, that the values of the moments change when at least one observed charged particle is reguired in the acceptance interval [4,5].

Table 2. The results of fitting the negative binomial distribution with parameters <n> and k to the multiplicity distribution in a central interval $|\eta| < \eta_c$. For the definition of y, see the text.

Table 3. The moments of the corrected multiplicity distributions in the pseudorapidity intervals of size $\Delta\eta$ = 0.4, 1 and 2 in non-central intervals. The errors given are statistical. We estimate the systematic error to be 1-3 times the statistical one. The systematic error is largest for the interval $\Delta\eta$ = 2 centred at η = 3, decreasing with interval size and centre of interval.

Table 4. The results of fitting the negative binomial distribution with parameters <n> and k to the multiplicity distribution in non-central intervals of size $\Delta\eta$ = 0.4, 1 and 2. For those values of <n> and k marked with * the fit to the negative binomial distribution is less satisfactory, and the resulting value of k is not plotted in figure 4.

TABLE 1

η_c	<n>	D_2	<n>/D_2	C_2	C_3	C_4	C_5
0.2	1.16±0.01	1.42±0.02	0.82±0.01	2.48±0.03	8.5±0.4	39±4	230±40
0.5	3.01±0.03	2.90±0.04	1.04±0.01	1.93±0.02	5.2±0.2	18±1	80±10
1.0	6.17±0.06	5.22±0.07	1.18±0.01	1.72±0.02	4.0±0.1	12.1±0.7	44± 5
1.5	9.49±0.08	7.46±0.09	1.27±0.01	1.62±0.01	3.55±0.08	9.9±0.5	33± 3
2.0	12.8±0.1	9.5±0.1	1.34±0.01	1.56±0.01	3.24±0.07	8.4±0.4	26± 2
2.5	15.9±0.1	11.3±0.1	1.40±0.01	1.51±0.01	3.00±0.06	7.4±0.3	21± 1
3.0	18.9±0.2	12.9±0.1	1.47±0.01	1.46±0.01	2.79±0.05	6.4±0.2	17± 1
3.5	21.4±0.2	14.1±0.2	1.52±0.01	1.43±0.01	2.62±0.04	5.8±0.2	14.8±0.7
4.0	23.6±0.2	14.9±0.2	1.58±0.01	1.40±0.01	2.49±0.04	5.3±0.1	12.9±0.6
4.5	25.2±0.2	15.5±0.2	1.63±0.01	1.38±0.01	2.37±0.03	4.9±0.1	11.4±0.5
5.0	26.4±0.2	15.7±0.2	1.68±0.01	1.35±0.01	2.28±0.03	4.6±0.1	10.3±0.4

TABLE 2

	All data points included		n=0 and n=1 excluded		All data points included	
η_c	χ^2 / DF	y	χ^2 / DF	y	<n>	k
0.2	10.0 / 9	0.3	8.7 / 7	0.6	1.16±0.02	1.57±0.09
0.5	8.1 / 16	−1.5	7.4 / 14	−1.3	3.00±0.04	1.68±0.06
1.0	41.8 / 27	1.9	29.5 / 25	0.7	6.14±0.06	1.80±0.05
1.5	45.2 / 37	1.0	26.0 / 35	−1.1	9.47±0.08	1.95±0.05
2.0	80.8 / 46	3.2	62.3 / 44	1.8	12.8±0.1	2.12±0.05
2.5	57.3 / 53	0.5	49.8 / 51	0.0	15.9±0.1	2.27±0.05
3.0	78.7 / 59	1.7	71.5 / 57	1.3	18.8±0.1	2.47±0.05
3.5	78.5 / 63	1.3	73.9 / 61	1.2	21.4±0.1	2.64±0.05
4.0	70.9 / 66	0.5	68.5 / 65	0.3	23.5±0.1	2.82±0.05
4.5	67.5 / 65	0.3	67.4 / 64	0.3	25.3±0.1	3.01±0.05
5.0	74.0 / 65	0.8	72.4 / 64	0.8	26.4±0.3	3.19±0.05

TABLE 3

$\Delta\eta = 0.4$

interval centre	<n>	D_2	<n>/D_2	C_2	C_3	C_4	C_5
0.5	1.22±0.01	1.45±0.01	0.84±0.01	2.42±0.02	8.1±0.2	35±1	180±10
1.0	1.30±0.01	1.51±0.01	0.86±0.01	2.36±0.02	7.7±0.2	31±2	170±20
1.5	1.30±0.01	1.49±0.01	0.87±0.01	2.31±0.02	7.2±0.1	28±1	130±8
2.0	1.27±0.01	1.44±0.01	0.88±0.01	2.29±0.02	7.0±0.1	27±1	129±9
2.5	1.21±0.01	1.38±0.01	0.88±0.01	2.30±0.02	6.9±0.1	26±1	110±10
3.0	1.10±0.01	1.27±0.01	0.87±0.01	2.33±0.02	7.1±0.2	28±2	140±20

$\Delta\eta = 1.0$

interval centre	<n>	D_2	<n>/D_2	C_2	C_3	C_4	C_5
0.5	3.07±0.02	2.94±0.03	1.05±0.01	1.92±0.01	5.1±0.1	17.3±0.8	72±7
1.0	3.21±0.02	3.02±0.02	1.06±0.01	1.88±0.01	4.9±0.1	16.2±0.7	65±5
1.5	3.27±0.02	3.01±0.02	1.09±0.01	1.85±0.01	4.62±0.08	14.4±0.5	53±3
2.0	3.18±0.02	2.89±0.02	1.10±0.01	1.82±0.01	4.44±0.06	13.0±0.3	46±2
2.5	3.01±0.02	2.70±0.02	1.11±0.01	1.81±0.01	4.31±0.07	12.6±0.5	44±4
3.0	2.75±0.02	2.45±0.01	1.12±0.01	1.79±0.01	4.17±0.06	11.8±0.4	39±2

$\Delta\eta = 2.0$

interval centre	<n>	D_2	<n>/D_2	C_2	C_3	C_4	C_5
0.5	6.24±0.06	5.21±0.06	1.20±0.01	1.70±0.01	3.92±0.09	11.4±0.6	40±4
1.0	6.37±0.04	5.28±0.04	1.21±0.01	1.69±0.01	3.87±0.07	11.2±0.4	39±3
1.5	6.42±0.04	5.23±0.04	1.23±0.01	1.66±0.01	3.70±0.05	10.2±0.3	33±2
2.0	6.29±0.04	5.02±0.04	1.25±0.01	1.64±0.01	3.51±0.04	9.1±0.2	27±1
2.5	5.93±0.04	4.64±0.03	1.28±0.01	1.61±0.01	3.35±0.04	8.3±0.2	23.4±0.8
3.0	5.33±0.03	4.11±0.02	1.30±0.01	1.60±0.01	3.23±0.04	7.8±0.2	21.6±0.9

TABLE 4

interval centre	$\Delta\eta$=0.4		$\Delta\eta$=1.0		$\Delta\eta$=2.0	
	<n>	k	<n>	k	<n>	k
0.5	1.22±0.01	1.65±0.06	3.06±0.03	1.68±0.04	6.23±0.07	1.84±0.05
1.0	1.30±0.01	1.67±0.06	3.21±0.03	1.73±0.04	6.35±0.03	1.86±0.02
1.5	1.30±0.01	1.78±0.07	3.27±0.02	1.81±0.02	6.41±0.04	1.92±0.03
2.0	1.27±0.01	1.93±0.09	3.17±0.02*	1.93±0.04*	6.25±0.04*	2.10±0.04*
2.5	1.21±0.01	1.99±0.09	3.01±0.02*	2.07±0.05*	5.92±0.03*	2.29±0.05*
3.0	1.11±0.01	2.1±0.1	2.76±0.02*	2.24±0.06*	5.39±0.04*	2.57±0.05*

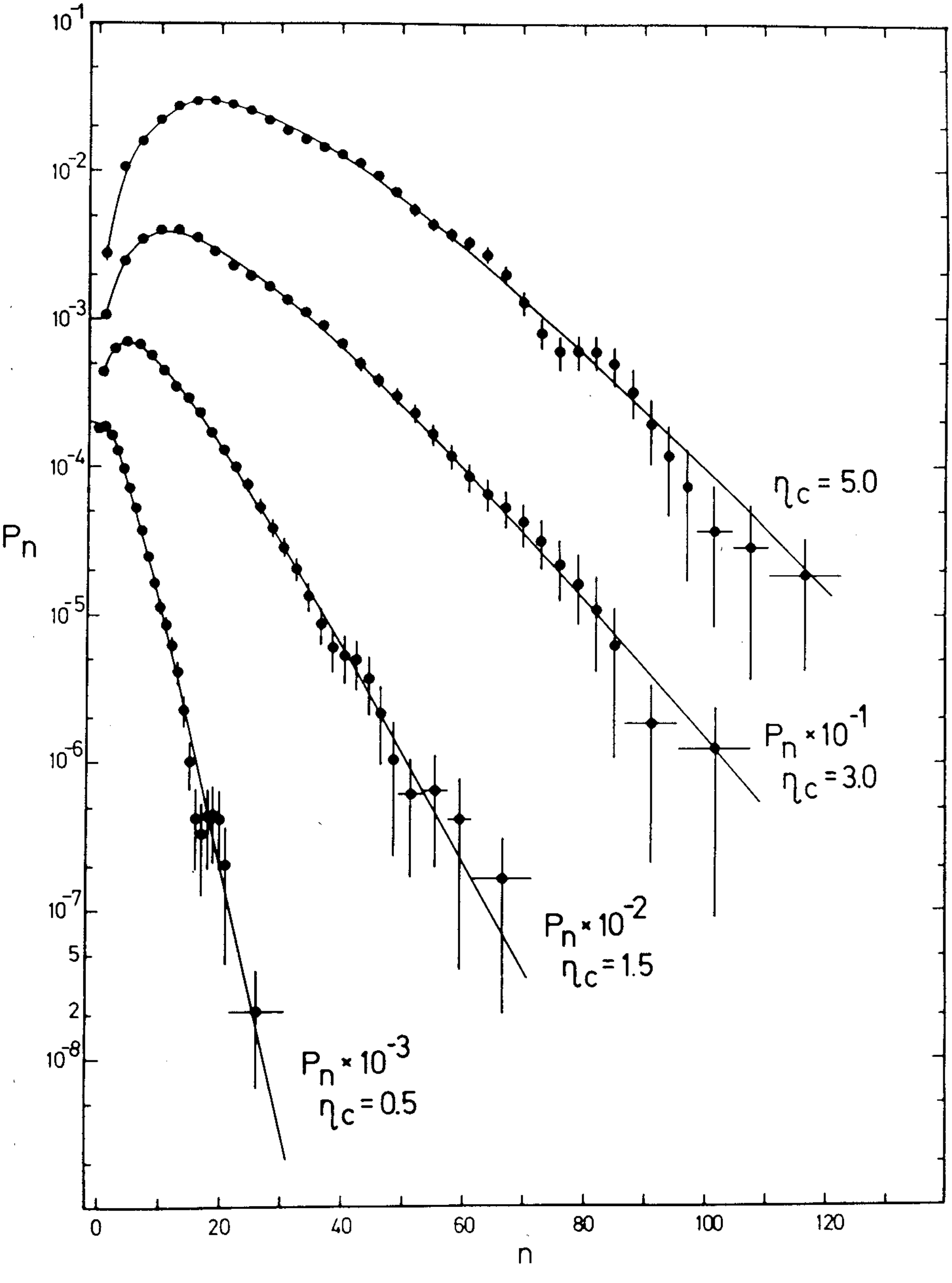
FIGURE CAPTIONS

Figure 1. Corrected charged multiplicity distributions in the pseudorapidity intervals $|\eta| < 0.5$, 1.5, 3.0 and 5.0, plotted in the variables P_n versus n (fig. 1a) and in the variables $\langle n \rangle P_n$ versus $z = n/\langle n \rangle$ (fig. 1b). The curves in fig 1a illustrate the negative binomial distributions with the parameters $\langle n \rangle$ and k given in table 2.

Figure 2. Values of the moments $C_q = \langle n^q \rangle / \langle q \rangle^q$, q=2–5, plotted as a function of the size of the pseudorapidity interval $|\eta| < \eta_c$.

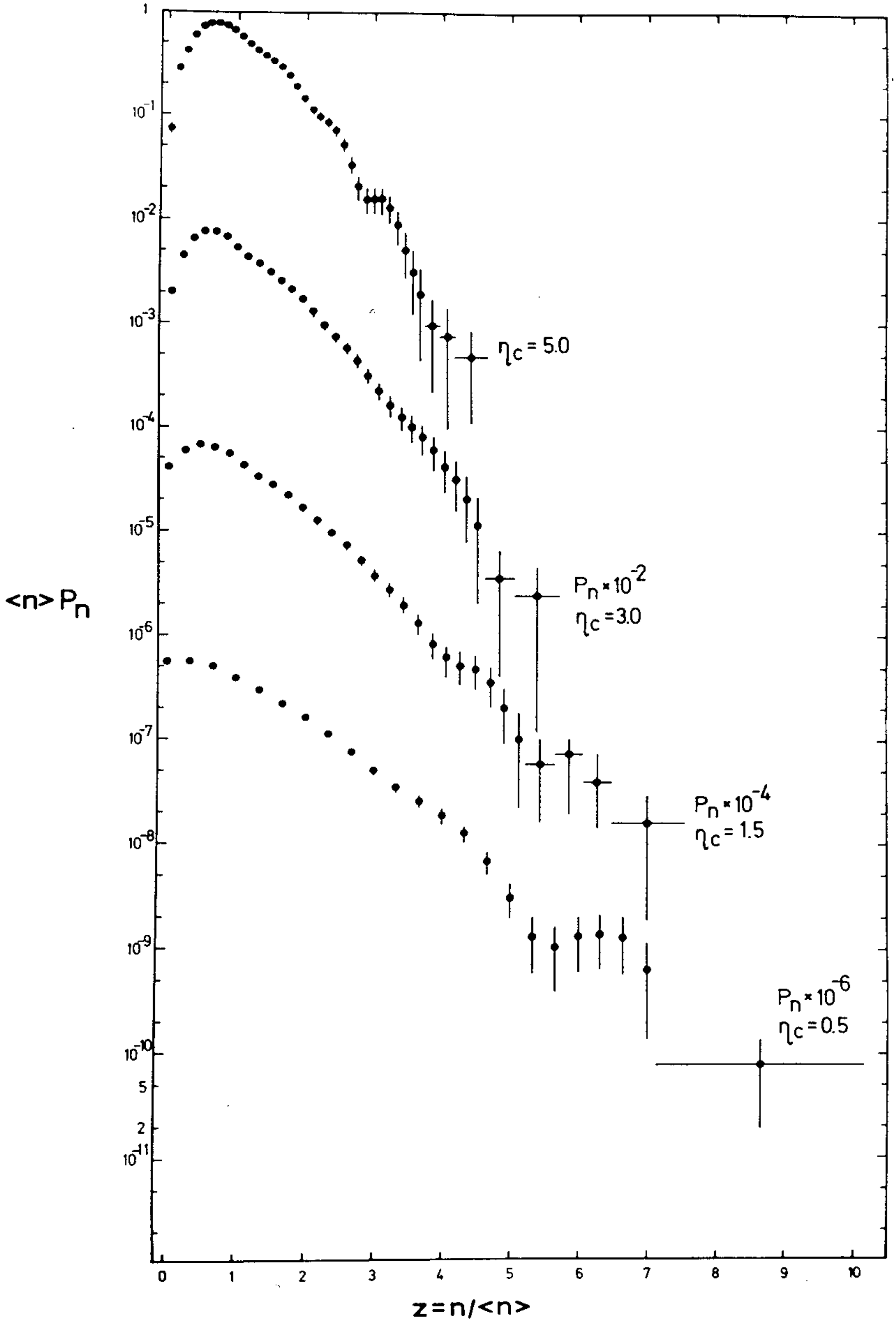
Figure 3. The negative binomial parameter k and its inverse k^{-1} plotted as a function of the size of the pseudorapidity interval η_c.

Figure 4. The k-values for $\Delta\eta = 0.4$, 1 and 2 plotted versus the centre of the intervals. We only show the k values for the cases with acceptable fits (see table 4)



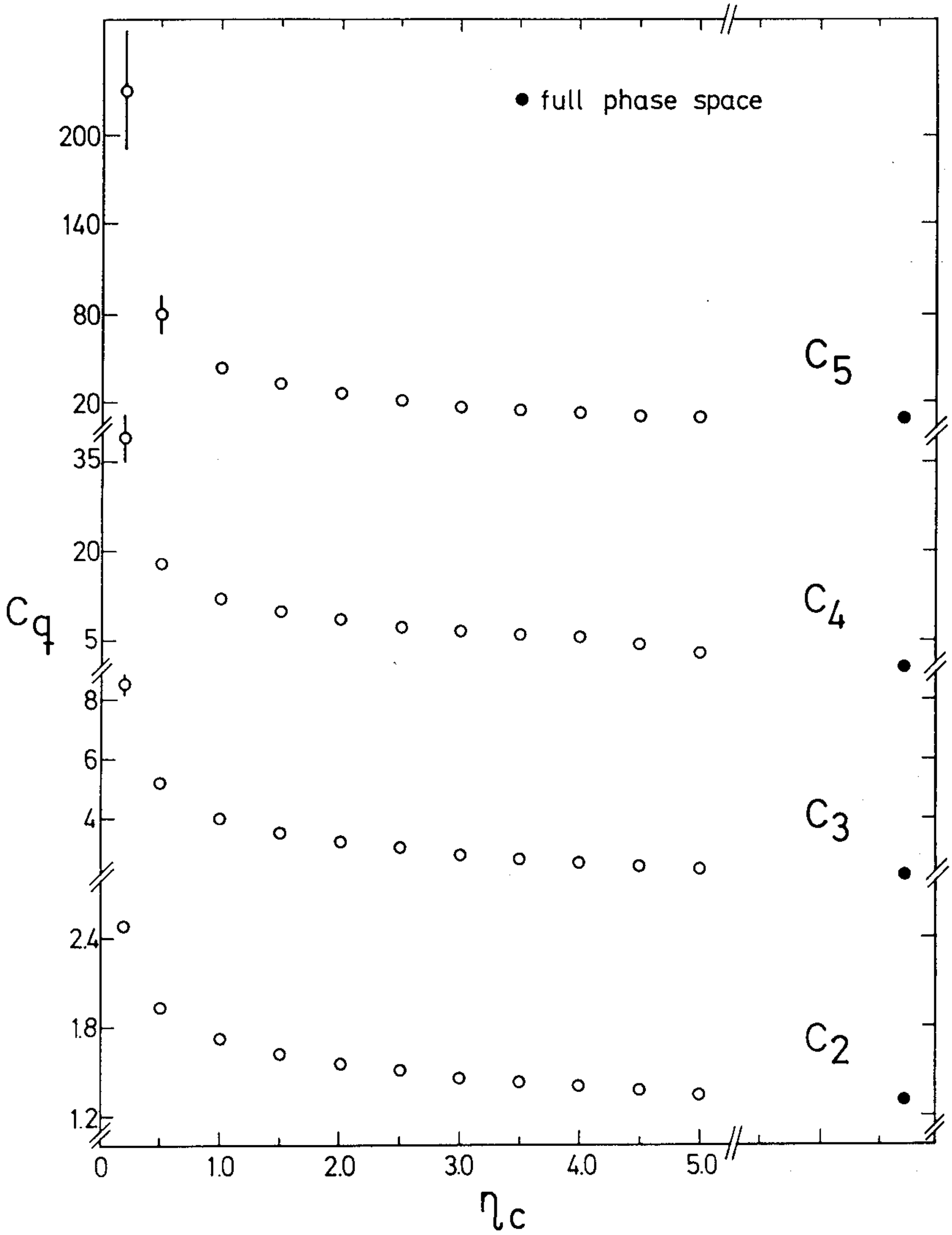
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
5
2
10^{-8}
P_n
0
20
40
60
80
100
120
n
$\eta_c = 5.0$
$P_n \times 10^{-1}$
$\eta_c = 3.0$
$P_n \times 10^{-2}$
$\eta_c = 1.5$
$P_n \times 10^{-3}$
$\eta_c = 0.5$

Fig. 1a



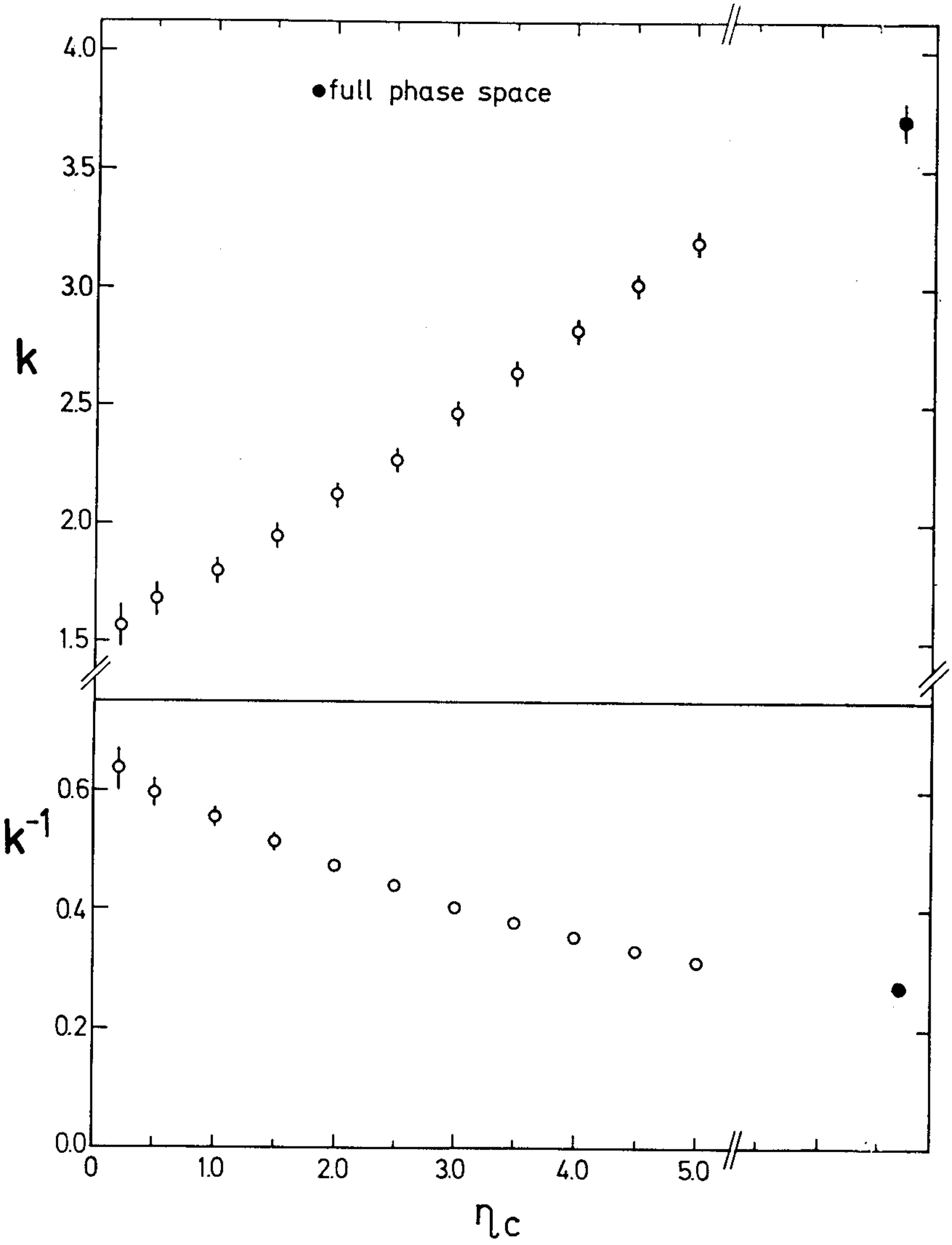
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
5
2
10^{-11}
$\langle n \rangle P_n$
$\eta_c = 5.0$
$P_n \times 10^{-2}$
$\eta_c = 3.0$
$P_n \times 10^{-4}$
$\eta_c = 1.5$
$P_n \times 10^{-6}$
$\eta_c = 0.5$
0 1 2 3 4 5 6 7 8 9 10
$z = n/\langle n \rangle$

Fig. 1b



full phase space
200
140
80
20
35
20
5
8
6
4
2.4
1.8
1.2
C_q
C_5
C_4
C_3
C_2
0
1.0
2.0
3.0
4.0
5.0
η_c

Fig. 2



●full phase space
k
4.0
3.5
3.0
2.5
2.0
1.5
k⁻¹
0.6
0.4
0.2
0.0
0
1.0
2.0
3.0
4.0
5.0
η_c

Fig. 3

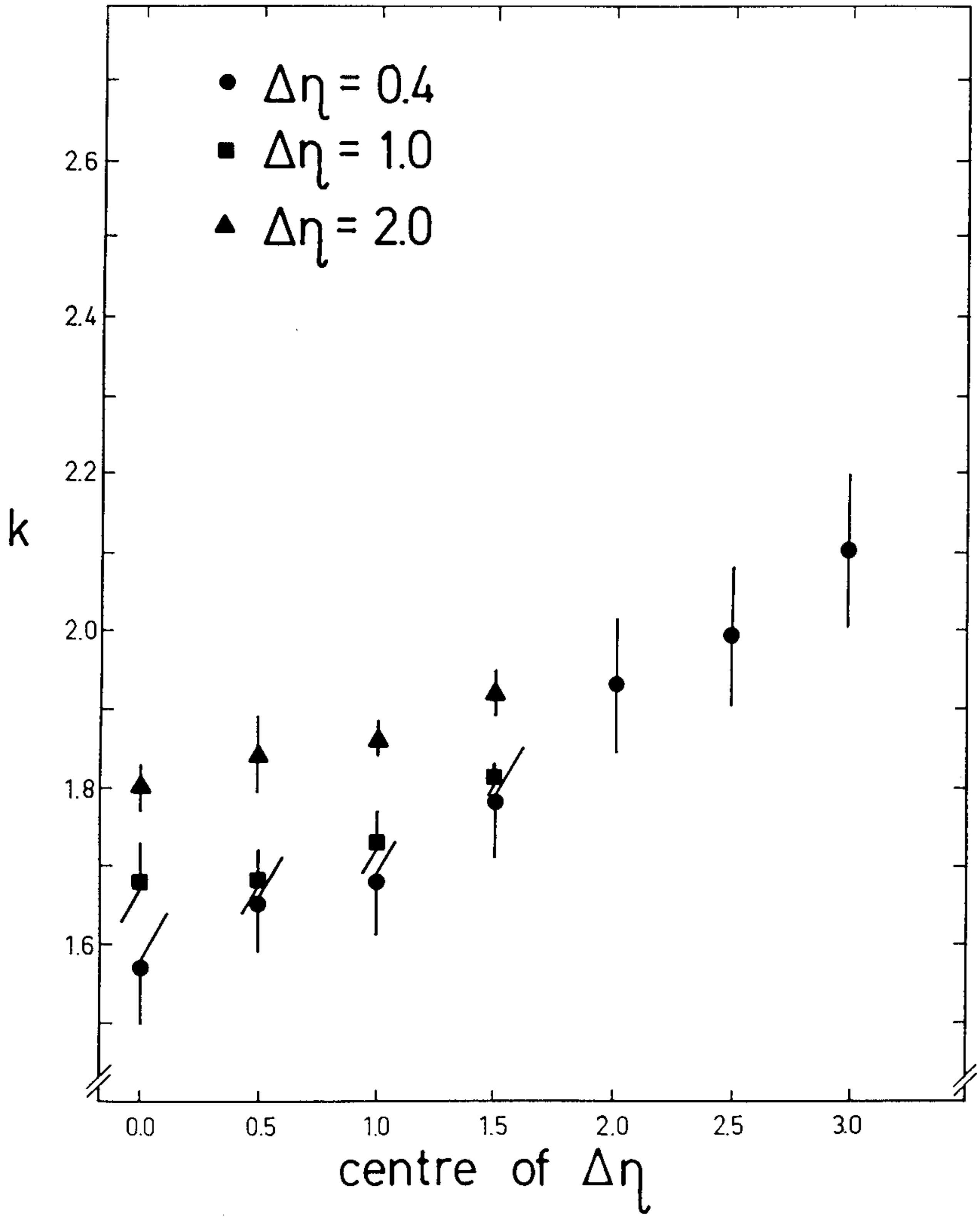


Fig. 4