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FORWARD-BACKWARD CORRELATIONS IN HADRON-NUCLEUS COLLISIONS

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Forward-backward correlations in high energy hadron-nucleus collisions are analyzed using a simple model that correctly describes correlations in hadron-hadron collisions. One finds that both in multiple scattering models and in "single effective scattering" models of hadron-nucleus interaction the main trends of the data are predicted correctly. However, more precise measurements should allow us to discriminate between models and to fix their free parameters.

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1. *Introduction*

Forward-backward correlations (FBC—correlations between global numbers in each CM hemisphere) may be regarded as the simplest correlation measurement. FBC can be investigated for very limited statistics, when it is not practical to divide phase-space in smaller bins to determine a differential correlation function. In colliding beams experiments the separation into CM hemispheres can be done without measuring momenta. Therefore measurements of FBC are particularly easy to perform and important whenever we investigate a new energy range or a new process, for which limited statistics are available. However, even for quite well-measured processes FBC contribute a valuable piece of information when testing specific models. This is because (*i*) FBC do not depend strongly on minor details of models (*ii*) one can often calculate them analytically, and (*iii*) one can investigate easily the effect of changing parameters on them.

Recently, new results relevant for models of multiple production were obtained by investigating FBC. A strong increase of the correlation parameter b between the ISR and SPS collider energies was reported [1, 2], showing the importance of long-range correla-

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tions extending over full phase-space. On the other hand, data from e^+e^- [3] and lh [4] interactions have failed yet to show similar effects. One has to wait for higher energies to see if the apparent universality of FBC as function of $\bar{n}$ suggested by low energy data [5] will continue or not.

It is therefore rather surprising that FBC have attracted till now very little attention in the investigations of hadron-nucleus collisions. There are few experimental results and even fewer theoretical predictions. The original formulation of long-range effects in the framework of reggeon theory [6] has been followed in the dual topological model in which FBC in both hadron-hadron [7] and hadron-nucleus interactions [8] have been described successfully. It is not clear, however, if these results distinguish the dual topological approach from other existing models of hadron-nucleus interactions.

In this note we do not try to discuss in detail any particular model of hadron-nucleus collisions. We simply make use of a successful description of FBC in hadron-hadron collisions by a so-called minimal model [9] to investigate semi-quantitative predictions for the hadronic-nucleus case resulting from obvious generalizations of this model. More specifically, we calculate FBC in the model where the production is treated as resulting from an effective single collisions and in which the formula of the minimal model is directly applied. Then we compare it to the picture where multiple consecutive collisions with target nucleons are assumed and where minimal model is applied to each collision separately. We also confront the predictions of two models with the existing data for incident momenta above 200 GeV/c (where the minimal model is applicable).

In Section 2 we present briefly the basic definitions, the minimal model used to describe pp and $\bar{\text{p}}$p collisions and its generalization to asymmetric case, which may be applicable directly to hadron-nucleus scattering in an effective single collision model. In Section 2 we calculate the correlation parameters in multiple collision model. In Section 4 we compare and discuss numerical results obtained in two pictures, and in Section 5 we compare them to data. We conclude with Section 6.

2. *A minimal model of FBC for asymmetric multiple production*

The commonly used FBC parameter is a slope b (linear regression) defined by a relation

$$\bar{n}_F(n_B) = \bar{n}_F + b(n_B - \bar{n}_B), \tag{1}$$

from which one obtains

$$b = (\overline{n_F n_B} - \bar{n}_F \bar{n}_B)/(\overline{n_B^2} - \bar{n}_B^2) = D_{FB}/D_B^2. \tag{2}$$

If the process described is not forward-backward symmetric, we must use also second independent parameter b' defined by

$$\bar{n}_B(n_F) = \bar{n}_B + b'(n_F - \bar{n}_F), \tag{3}$$

$$b' = D_{FB}/D_F^2. \tag{4}$$

A minimal model has been formulated [2] as a model in which the distribution of particles between hemispheres for fixed global multiplicity n is random, i.e. given by the binomial formula

$$P(n_F)|_n = \binom{n}{n_F} p^{n_F}(1-p)^{n_B}, \tag{5}$$

where obviously

$$n_B + n_F = n \tag{6}$$

and

$$p = \frac{\bar{n}_F}{\bar{n}}. \tag{7}$$

This is equivalent [9] to a model in which the multiplicity distribution is a superposition of Poisson distributions [10]

$$P(n) = \int_0^\infty d\lambda e^{-\bar{n}\lambda} \frac{(\bar{n}\lambda)^n}{n!} \psi(\lambda). \tag{8}$$

Since for given λ there are no correlations, we have independent Poisson distributions in both hemispheres

$$P(n_F)|_\lambda = e^{-\bar{n}\lambda p} \frac{(\bar{n}\lambda p)^{n_F}}{n_F!}, \tag{9}$$

$$P(n_B)|_\lambda = e^{-\bar{n}\lambda(1-p)} \frac{[\bar{n}\lambda(1-p)]^{n_B}}{n_B!}. \tag{10}$$

For pp or $\bar{p}$p collisions we have obviously $p = 1/2$ and calculating D^2

$$D_F^2 = D_B^2 = \tfrac{1}{4}(D^2 + \bar{n}) \tag{11}$$

and consequently

$$D_{FB} = \tfrac{1}{2}(D^2 - D_F^2 - D_B^2) = \tfrac{1}{4}(D^2 - \bar{n}) \tag{12}$$

we find

$$b = b' = \frac{D^2 - \bar{n}}{D^2 + \bar{n}}. \tag{13}$$

In a general case, analogous calculations give

$$D_F^2 = p^2 D^2 + p(1-p)\bar{n}, \tag{14}$$

$$D_B^2 = (1-p)^2 D^2 + (1-p)\bar{n} \tag{15}$$

and thus

$$b = \frac{p(D^2-\bar{n})}{(1-p)D^2+p\bar{n}}, \tag{16}$$

$$b' = \frac{(1-p)(D^2-\bar{n})}{pD^2+(1-p)\bar{n}}. \tag{17}$$

In a realistic version of minimal model one should assume random emission of clusters, and not directly hadrons, to account for known short-range correlations [2]. This amounts to replacing $\bar{n}$ in formulae (11)–(17) by

$$K\bar{n} = \frac{\overline{k^2}}{\bar{k}}\bar{n}, \tag{18}$$

where $\bar{k}$ and $\overline{k^2}$ denote the average multiplicity and multiplicity squared in cluster decay. This is because the Poisson distribution for clusters (with average given by $\lambda\bar{n}/\bar{k}$) results in the dispersion squared in the multiplicity distribution of hadrons given by

$$D^2|_\lambda = \lambda\frac{\bar{n}}{\bar{k}}\overline{k^2} = \lambda K\bar{n}. \tag{19}$$

Finally, to account for phase-space corrections to independent emission it is sufficient (for CM energies above 20 GeV) to replace (19) by [9]

$$D^2|_\lambda = \lambda K\bar{n}-c_\lambda \tag{20}$$

resulting in

$$b = \frac{p(D^2-K\bar{n}+c)}{(1-p)D^2+p(K\bar{n}-c)}, \tag{21}$$

$$b' = \frac{(1-p)(D^2-K\bar{n}+c)}{pD^2+(1-p)(K\bar{n}-c)}, \tag{22}$$

where c is a free constant parameter. These formulae with $p = 1/2$ coincide and describe well pp and $\bar{\text{p}}$p data in the ISR-SPS collider energy range [1, 2] for $K = 2.5 \div 3$ (as required by short-range correlation data) and $c \simeq 10$ [9]. In fact, at collider energies the value of c is irrelevant as long as it is not too big.

Formulae (21) and (22) may be directly applied to a hadron-nucleus collision if one assumes a picture with a single effective interaction, resembling closely a hadron-hadron collision. Obviously, now $p \neq 1/2$ and its value should be taken from data according to (7) as well as the D^2 and $\bar{n}$ values.

Let us stress here that this model should not be identified with any of the "collective tube" models [11], although it may approximate results of such model. Our basic assumption is that the multiple production in hadron-nucleus collisions can be decomposed into "independent cluster emission" processes in a similar way to what was done in hadron-

-hadron collisions. These "elementary" processes should differ in average multiplicities, but *not* in values of $p = \bar{n}_F/\bar{n}$. To simplify the presentation, we will use in the following an empirical relation

$$D \simeq \alpha\bar{n} \tag{23}$$

which for $\alpha \simeq 0.5\div 0.6$ is successful for both hadron-hadron and hadron-nucleus processes. Then we find

$$b = \frac{\bar{n}_F(\alpha^2\bar{n}^2 - K\bar{n} + c)}{\alpha^2(\bar{n}-\bar{n}_F)\bar{n}^2 + \bar{n}_F(K\bar{n}-c)}, \tag{24}$$

$$b' = \frac{(\bar{n}-\bar{n}_F)(\alpha^2\bar{n}^2 - K\bar{n} + c)}{\alpha^2\bar{n}_F\bar{n}^2 + (\bar{n}-\bar{n}_F)(K\bar{n}-c)}. \tag{25}$$

Let us note here that the assumption of $\bar{n}_F/\bar{n}$ independent on λ is definitely in disagreement with multiple scattering models, where for different number of collisions we expect usually different $\bar{n}_F/\bar{n}$ values. Then the naive generalization of a minimal model for FBC presented above is useful as a reference point to be compared with other predictions, even if it does not correspond directly to any fashionable model of hadron-nucleus interactions.

3. *FBC in multiple collision model*

Multiple collision models have been used extensively for the description of hadron-nucleus interactions [12]. It is well-known that, in particular, the inclusive spectra do not agree with a simple expectation obtained by multiplying a spectrum from hadron-hadron interaction by the average number of collisions $\bar{\nu}$. In the forward CM hemisphere the nuclear enhancement is much weaker, and for very fast particles one observes in fact even a depletion for increasing nuclear mass. On the other hand, in the backward hemisphere the enhancement for very slow particles (in the laboratory system) is much stronger than by a $\bar{\nu}$ factor, which probably reflects cascading inside the nucleus. Any realistic model should take into account these facts. We make here two simple assumptions:

(*i*) first collision leads to the same production as scattering on a free nucleon (characterized by average multiplicity $\bar{n}_1$ and dispersion D_1^2), obviously symmetric in CM frame for a nucleon beam

(*ii*) each next collision leads in average to the production of $\bar{n}_1/2$ backward particles and $\varepsilon\bar{n}_1/2$ forward particles, where ε is a small positive constant parameter.

As we see, nuclear cascading is neglected, which may be a reasonable approximation in case of negative particles. This may be improved, if we can estimate average multiplicity in a cascade and its correlation with the number of originally produced particles, since all the cascade particles are obviously produced at high energy in the backward CM hemisphere. We will present later an estimate of this effect. We also neglect here the energy degradation of colliding particles in consecutive collisions.

With these assumptions we find obviously for the first collision

$$D_{F1}^2 = D_{B1}^2 = \tfrac{1}{4}(D_1^2 + \bar{n}_1), \tag{26}$$

and for any later collision (assuming the same $\psi(\lambda)$) we find

$$D_i^2 = \left(\frac{1+\varepsilon}{2}\right)^2 D_1^2 + \frac{1-\varepsilon^2}{4}\bar{n}_1, \tag{27}$$

$$D_{Fi}^2 = \left(\frac{\varepsilon}{2}\right)^2 D_1^2 + \frac{\varepsilon}{2}\left(1-\frac{\varepsilon}{2}\right)\bar{n}_1, \tag{28}$$

$$D_{Bi}^2 = \tfrac{1}{4}(D_1^2+\bar{n}_1). \tag{29}$$

Thus for the global dispersion we find

$$D^2 = D_1^2+(\bar{\nu}-1)D_i^2+D_\nu^2\bar{n}_1^2\left(\frac{1+\varepsilon}{2}\right)^2, \tag{30}$$

where D_ν^2 denotes the dispersion in the number of collision

$$D_\nu^2 = \overline{\nu^2}-\bar{\nu}^2, \tag{31}$$

and similarly

$$D_F^2 = D_{F1}^2+(\nu-1)D_{Fi}^2+D_\nu^2\bar{n}_1^2\left(\frac{\varepsilon}{2}\right)^2, \tag{32}$$

$$D_B^2 = D_{B1}^2+(\bar{\nu}-1)D_{Bi}^2+D_\nu^2\,\frac{\bar{n}_1^2}{4}. \tag{33}$$

As before, introducing clusters and phase-space corrections changes $\bar{n}_1$ in formulae (26)–(29) into $K\bar{n}_1-c$. Thus calculating correlation parameters b and b' we have

$$b = \frac{(D_1^2-K\bar{n}_1+c)\,[1+(\bar{\nu}-1)\varepsilon]+\varepsilon D_\nu^2\bar{n}_1^2}{(D_1^2+K\bar{n}_1-c)\bar{\nu}+D_\nu^2\bar{n}^2}, \tag{34}$$

$$b' = \frac{(D_1^2-K\bar{n}_1+c)\,[1+(\bar{\nu}-1)\varepsilon]+\varepsilon D_\nu^2\bar{n}_1^2}{(D_1^2+K\bar{n}_1-c)+(\bar{\nu}-1)\varepsilon[\varepsilon D_1^2+(2-\varepsilon)\,(K\bar{n}_1-c)]+\varepsilon^2D_\nu^2\bar{n}_1^2}. \tag{35}$$

To use these formulae we have to know not only $\bar{n}_1$, D_1^2, K and c (which are to be taken from nucleon-nucleon collision) but also ε, $\bar{\nu}$ and D_ν^2. $\bar{\nu}$ can be calculated from cross-sections according to formula

$$\bar{\nu} = \frac{A\sigma_{NN}}{\sigma_{NA}}. \tag{36}$$

The estimate for ε comes from the average multiplicity

$$\bar{n} = \bar{n}_1\left[1+(\bar{\nu}-1)\,\frac{1+\varepsilon}{2}\right]. \tag{37}$$

Finally, D_ν^2 can be estimated from an empirical relation

$$\frac{D^2}{\bar{n}^2} \simeq \frac{D_1^2}{\bar{n}^2}. \tag{38}$$

For $\varepsilon \ll 1$ and $D_1^2 \gg \bar{n}_1$ this yields

$$D_\nu^2 \simeq \frac{D_1^2}{\bar{n}_1^2}(\bar{\nu}+2)(\bar{\nu}-1). \tag{39}$$

Estimates for ε and D_ν^2 are rather crude and we will have to check carefully how strongly the predictions of the model depend on these values. In addition, we have to remember the uncertainty related to the cascade contribution to multiple production.

To estimate this effect, let us assume that for each collision the number of backward produced particles is enhanced simply by adding $\bar{n}_{c1}$ particles, which are correlated to the "originally produced" particles according to a distribution similar to the original one (8). Then it is easy to check that the correlation parameter b' increases compared to the values from formula (35) by a factor

$$b' \to b'\left(1+\frac{2\bar{n}_{c1}}{\bar{n}_1}\right) = b'\left(1+\frac{2\bar{n}_c}{\bar{\nu}\bar{n}_1}\right), \tag{40}$$

where $\bar{n}_c$ denotes the global average multiplicity of cascade products. Correcting parameter b is more complicated, since both D_B^2 and D_{BF}^2 increase by taking into account cascade particles. We have found that for simple assumptions concerning the multiplicity distribution [17] and roughly estimated average number of cascade particles b values should also increase due to cascading. However, this result depends on poorly estimated experimental numbers, and in any case the correction is rather small. Thus we restrict in the following the discussion of cascade corrections to the parameter b'. In the "single collision" picture including cascade does not change formulae (24), (25), and the corrections via changing values of D^2, $\bar{n}$ and p are negligible for our purposes.

4. *Numerical results*

We have performed calculations of correlation parameters according to formula (34), (35) for $\bar{n}_1$ between 7.5 and 12 and $\bar{\nu}$ between 1 and 4 (note that n, n_1 etc. denote now the numbers of *charged* hadrons). This corresponds approximately to $\sqrt{s}$ values per NN collision between 20 and 50 GeV, and the full range of nuclei. At lower energies our approximation of phase-space effects is unreliable, and the upper limit already exceeds energies available now and in the near future for collisions with nuclei.

The values of K and c parameters were taken from the description of pp data. For convenience, we have used the empirical approximate formula

$$D_1 = \alpha\bar{n}_1. \tag{41}$$

We have found that pp and $p\bar{p}$ data are similarly well described for two sets of parameter values

$$\alpha \simeq 0.58, \quad K = 3, \quad c = 10 \tag{42}$$

$$\alpha = 0.50, \quad K = 2.5, \quad c = 10. \tag{43}$$

Thus we have checked if results for hadron-nucleus interaction using these two sets will differ. We have found that within few percent the results are the same and in the following we will discuss only those corresponding to set (42).

The parametrization of D_ν^2 (39) was compared to the values calculated from a classical Monte Carlo model [13] using experimental values of inelastic cross-section and nuclear sizes. The differences were always in the few percent range and did not influence visibly the values of the correlation parameters.

Therefore the only parameter left is ε, the percentage increase of forward average multiplicity by second and later collisions. We have tried values of ε between 0 and 0.3. Such values agree with formula (37) and data, although the division of $\bar{n}$ into $\bar{n}_F$ and $\bar{n}_B$ does not usually follow our assumptions in Section 3. This may be the result of cluster decay, "smearing out" the border between hemispheres, and thus enhancing $\bar{n}_F$, which has been smaller.

To facilitate the comparison with "effective single collision" picture of Section 2 we have compared b and b' values from formulae (24), (25) for the same $\bar{n}$ and $\bar{n}_F$ values which were obtained in the multiple collision model for quoted values of $\bar{n}_1$, ν and ε. Obviously, these parameters do not have any meaning in the "single collision" picture, but in this way we show the predictions of the two models for correlation parameters which give the same $\bar{n}$, D^2 and $\bar{n}_F$ for given energy and atomic mass.

The results for $\bar{\nu} = 1, 2.5$ and 3.5 as functions of $\bar{n}_1$ and for $\bar{n}_1 = 8$ (corresponding to $p_L \simeq 200$ GeV/c) as a function of $\bar{\nu}$ are shown in Figs 1 and 2 together with some data points which will be discussed later. We see from Figs 1a and 2a that for $\varepsilon = 0.1$, the models differ significantly only for heaviest nuclei and lowest energy. In all cases b' grows rather fast with $\bar{\nu}$ and b falls down slowly. The increase with $\bar{n}_1$ (and hence with energy) is rather slow and not very different from pp case, although one may note here that the energy dependence is significantly flatter in the multiple collisions model.

For $\varepsilon = 0.2$ we see in Figs 1b and 2b a significantly faster rise of b' with $\bar{\nu}$ for the multiple collision model. Therefore the values for $\bar{\nu} = 2.5$ and 3.5 lie now much higher for all $\bar{n}_1$, although the slope of the $\bar{n}_1$ dependence seems to be unchanged. We do not show the results for $\varepsilon = 0$ and $\varepsilon = 0.3$. In both cases the results of the "single collision" model are quite similar to the presented ones. The multiple collision model, however, predicts for $\varepsilon = 0$ for all nuclei

$$b' = b_{pp}. \tag{44}$$

This situation corresponds to the "wounded nucleon model" proposed and re-discovered in the last twenty years by many authors [12]. In this model the fragmentation of the nucleon (and thus $\bar{n}_F$) does not depend on the number of collisions, hence only the first collision contributes to FBC. The data, as we will see, seem to exclude this possibility.

For $\varepsilon = 0.3$ the predictions for b' seem to be unacceptably high for heavier nuclei. Thus we may conclude that FBC in the multiple collision model are quite sensitive to the

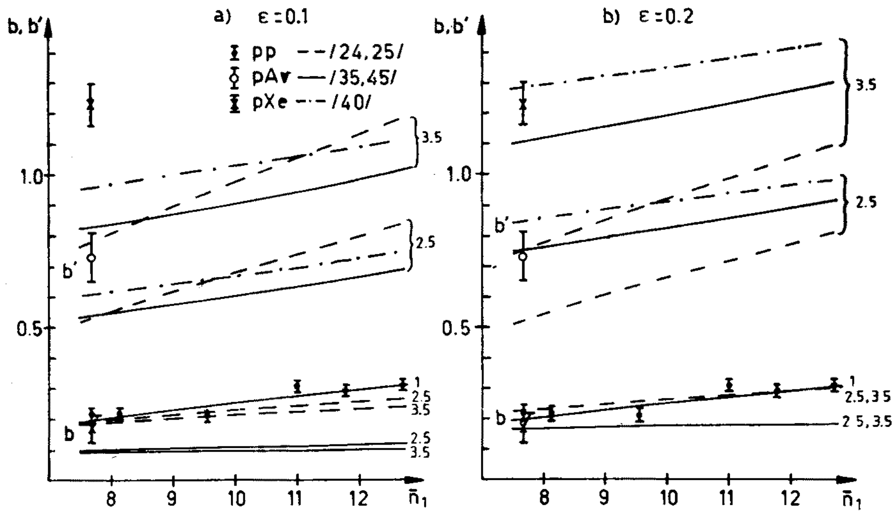

Fig. 1. Correlation parameters b and b' in pA interactions as functions of average pp multiplicity $\bar{n}_1$. Model predictions are shown as broken lines (24), (25) and solid lines (34), (35), $\bar{\nu}$-values are marked at the right-hand side of the curves. Dash-dotted lines represent predictions corrected for cascade effects (40). Data are for pp (dots), pAr (circles) and pXe (crosses) interactions [2, 16]. a) $\varepsilon = 0.1$, b) $\varepsilon = 0.2$

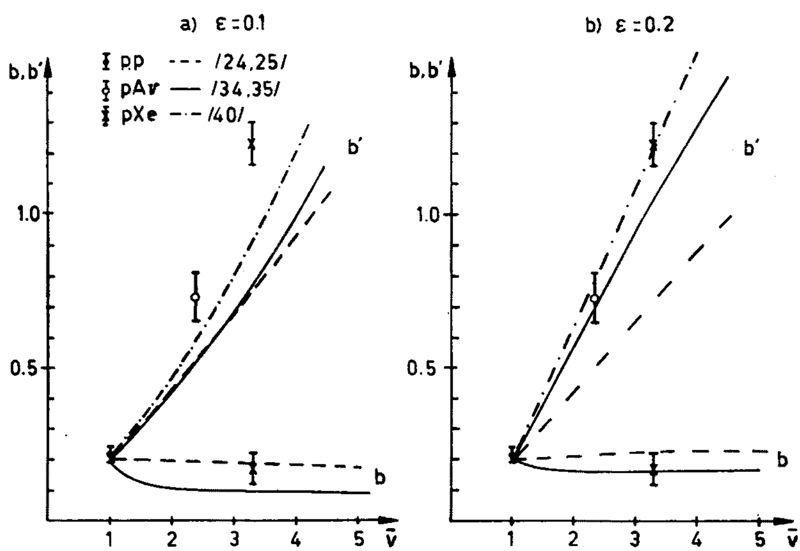

Fig. 2. Correlation parameters b and b' in pA interactions as functions of average number of collisions $\bar{\nu}$ for $\bar{n}_1 = 8$. Model parameters and symbols as in Fig. 1. a) $\varepsilon = 0.1$, b) $\varepsilon = 0.2$

value of ε. Since any detailed model of this type has to contain a similar parameter, we may claim that FBC are particularly well suitable for testing the assumptions concerning multiplication of *forward* particles by consecutive collisions and/or fixing the free parameters related to this effect. As mentioned above, the careful examination of $\bar{n}_1$- (or energy-) dependence of b' may be used to test the basic assumption of the "multiple collision" versus "single collision" picture. This, however, may be more difficult in models where ε is a function of energy and/or changes in consecutive collisions. This is the case in the dual topological model, where ε should approach 1 at high energy, or in the wounded quark model, where $\varepsilon \neq 0$ only for the first two (for meson beam) or three collisions [12]. Nevertheless, these models should also differ quite clearly in the predicted $\bar{\nu}$ and $\bar{n}_1$ dependence of correlation parameters.

5. *Comparison with data*

The subject of FBC in high energy collisions with nuclei has been investigated in few experimental papers. Most of the data refer to interaction with nuclear emulsion [14–16]. This is not particularly suitable for simple comparison with models, since averaging over various nuclei introduces spurious FBC, which mix with the ones characteristic for a given nucleus. It is also not quite clear if the "shower particles" include some cascade products, as the excess charge is usually not known. Moreover, the fitted values of b and b' quoted in [14] do not agree with data of [15] and in [16] the authors show only the plots of differently defined A, B, R (with obvious incompatibility between the definition and plotted values of the AB product) which are not sufficient to calculate b and b'. Thus the only statement one can make about the published emulsion data in the energy range 200–400 GeV/c is that for $\bar{\nu} \simeq 2.6$ and $\bar{n}_1 \simeq 8\div 9$, b' is larger than for $\bar{\nu} = 1$ and has values between 0.4 and 0.1 (possibly rising with energy within this range) and b is equal to or smaller than for $\bar{\nu} = 1$ with no visible energy dependence. This agrees quite well with the predictions of Figs 1, 2, but does not really test the models. We shall note here, however, that emulsion data potentially offer the interesting possibility of testing formulae (34), (35) in detail by changing $\bar{\nu}$ and D_ν^2. This can be done by selecting events with given numbers of "grey", "black" or "heavy" prongs, correlated in a rather well-known way to the number of collisions [17].

At present, however, more information can be drawn from NA5 data at 200 GeV/c [18] which include values of b' for Ar and Xe nuclei ($\bar{\nu} \simeq 2.3$ and 3.3) and p, $\bar{\text{p}}$ beams compared with results for pp and $\bar{\text{p}}$p interactions. Obviously "produced" particles counted here (i.e. all except identified protons) include at least some cascade products. Their minimal average multiplicity $\bar{n}_c$ may be estimated from the measured average positive charge excess in the backward hemisphere, which is 1.63 ± 0.12 for Ar and 2.78 ± 0.11 for Xe. Since in $\bar{\text{p}}$p collisions the excess charge among the "produced" particles is 0.57 ± 0.04, we expect that 57% of the "original charge excess", i.e. $\bar{\nu}Z/A$ is included in these numbers. Thus we are left with about 1 excess positive particle for Ar and 2 particles for Xe. Obviously, if cascading produces also pairs of charged pions, the true average multiplicity of cascade products counted as "produced particles" is higher, and our estimate should be regarded as lower limit of the necessary correction. This leads at 200 GeV/c ($\bar{n}_1 \simeq 8$) to a 10% increase of b' for $\bar{\nu} \simeq 2.5$ and 15% increase for $\bar{\nu} \simeq 3.5$. We have shown in Fig. 1 "corrected" predictions of the multiple collision model using the $\bar{n}_c$ values for all the $\bar{n}_1$ range, as the number of cascade particles should not change significantly in the considered range.

We see that these predictions for $\varepsilon = 0.1$ and $\varepsilon = 0.2$ bracket the data, suggesting that these parameter values are preferred. We do not perform any detailed fitting, as our cascade corrections represent only a lower limit. On the other hand, prediction from the "single collision" picture (25) significantly underestimate the data. Thus we may conclude that our toy model of this type is unrealistic. Predictions for b parameter are always similar within the inaccuracy of our estimates for cascade corrections and therefore are not suitable for model testing.

To predict the $\bar{\nu}$-dependence of cascade corrections to b' we have to assume how $\bar{n}_c$ depends on $\bar{\nu}$. We use $\bar{n}_c \propto \bar{\nu}^2$, which agrees with our values for Ar and Xe and follows from simple geometrical considerations. Obviously, results for $\varepsilon = 0.1$ and 0.2 again bracket the data.

6. *Conclusions and outlook*

We have investigated forward-backward correlations (FBC) in the hadron-nucleon collisions. Motivated by the success of a very simple "minimal model" for FBC in (anti-) nucleon-nucleon collisions we have generalized it to the hadron-nucleus case. We have found that a simple, but realistic multiple collision model with the "minimal model" assumed for FBC in each collision is compatible with the data. In fact, a naive generalization of the "minimal model" to the asymmetric production on nuclei using "simple effective collisions" also gives similar results at energies available now, but seems to underestimate experimental values of correlation coefficients. With increased accuracy and extended energy range FBC measurements should allow to discriminate easily between various models of hadron-nucleus interactions, and at least they will fix some assumptions and parameter values. Thus measuring FBC in nuclear experiments in addition to the standard parameters of multiplicity distribution is highly advisable. One may hope that FBC will be similarly helpful in investigating the mechanism of nucleus-nucleus collisions. This subject is at present under investigation.

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