LETTERS TO THE EDITOR

DECAY DISTRIBUTIONS OF CLANS AND FORWARD-BACKWARD CORRELATIONS IN THE GIOVANNINI-VAN HOVE MODEL*,**

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The forward-backward correlations in $p\bar{p}$ collisions are calculated using the Giovannini-Van Hove model with identical clusters. The results are shown to be in disagreement with the data at 540 GeV c. m. energy. Possible generalizations of the model are suggested.

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At high energy, the multiplicity of charged particles produced in (pseudo) rapidity intervals

$$|\eta| \leqslant \eta_c \tag{1}$$

follows the negative binomial distribution:

$$P(n, \langle n\rangle, k) = \frac{\Gamma(k+n)}{\Gamma(k)\Gamma(n)} \left(\frac{\langle n\rangle/k}{1+\frac{\langle n\rangle}{k}}\right)^n \left(1+\frac{\langle n\rangle}{k}\right)^{-k}, \tag{2}$$

where $\langle n\rangle$ is the average multiplicity and k is a parameter [1]. Both $\langle n\rangle$ and k increase with increasing size of the interval η_c.

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Giovannini and Van Hove observed [2] that independent production of clusters of particles leads to negative binomial distribution (2) provided that the distribution in cluster decay is of the form:

$$W(n) = \frac{-1}{\ln(1-b)} \frac{b^n}{n}, \quad 0 < b < 1, \tag{3}$$

where the parameter b is related to the average multiplicity in cluster decay by:

$$n_c = \frac{-b}{(1-b)\ln(1-b)}. \tag{4}$$

In a recent note [3] we used the data of Ref. [1] to obtain quantitative statements about the distribution of Giovannini–Van Hove clusters (called "clans" [7]) in rapidity and about angular distribution in their decay. We considered a simple extension of the model of Ref. [2] assuming that all clans decay identically with the angular distribution given by:

$$\chi(\eta) = \left(2\omega \cosh^2 \frac{\eta}{\omega}\right)^{-1}, \tag{5}$$

where ω is a free parameter determining the width d of the distribution, $d = 1.81\,\omega$ ($\omega = 1$ for isotropic decay). For the (pseudo) rapidity distribution of clans the shape suggested by bremsstrahlung analogy and longitudinal phase space [4], [5] was used:

$$\frac{dN}{dy} = \lambda(1-x^+)^\lambda(1-x^-)^\lambda, \quad x^\pm = \frac{m}{\sqrt{s}} e^{\pm y}, \tag{6}$$

where λ is a parameter (plateau height), m is the transverse mass of the clan, y is the clan (pseudo) rapidity and s is the total c.m. energy.

It was shown in Ref. [3] that the data can be reproduced with these new assumptions. The parameters of the model were determined:

$$\lambda = 0.855, \quad m = 3.15\ \text{GeV},$$

$$\omega = 1.45, \quad b = 0.90. \tag{7}$$

This gives $n_c = 3.94$ and average number of clans $\bar{N} = 7.25$.

The determination of the distribution and decay width of the clans allows one to calculate correlation between the particles produced in forward and backward hemispheres. The results are shown in Fig. 1. It can be seen that the calculated correlation is much weaker than that observed in the data of UA5 collaboration [6] also shown in Fig. 1. We conclude that the determined multiplicity n_c and/or the clan width parameter ω are too small to obtain the observed correlations[1].

[1] The importance of forward-backward correlations for testing the model of Ref. [2] was realized by UA5 Collaboration (K. Ekspong, private communication).

The question then arises if it is possible to describe the multiplicity data with significantly larger n_c and ω. Our analysis shows that this is not possible if all produced clans are identical. If this condition is relaxed, however, other fits may be allowed. In particular, in view of the amount of phase space available for fragmentation, it seems natural that

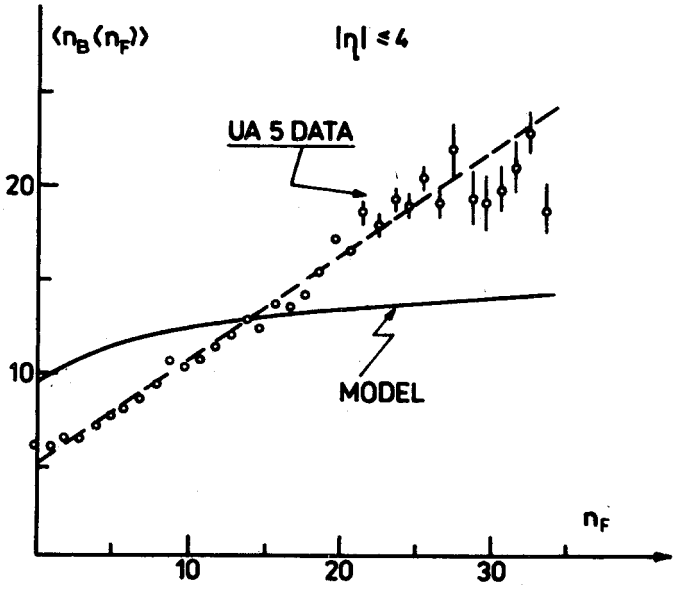

Fig. 1. Calculated forward-backward correlations compared to UA5 data [6]

clans produced in central rapidity region should be larger and broader than those produced at large values of rapidity[2]. Although such a model with clan parameters varying with y is by far more flexible than that considered in the present paper, it remains to be seen if it can indeed describe the multiplicity data.

In conclusion, using the data on multiplicity distributions, we have determined the average multiplicity and decay width of the clans in the Giovannini–Van Hove model. They turn out to be too small to explain forward–backward correlations observed by UA5 Collaboration.

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