

STUDY OF MULTIPARTICLE PRODUCTION IN 300 GeV PROTON-  
NUCLEUS INTERACTION THROUGH RAPIDITY SPACE  
DISTRIBUTION

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This paper presents an analysis of multiparticle production at 300 GeV p-nucleus interaction in emulsion through rapidity space distribution. It has been observed from this analysis that multiparticle production in proton-nucleus interaction at this energy proceeds via an intermediate cluster state.

### *1. Introduction*

Recently a large number of papers have been devoted to search for the correlation and the clustering of secondary particles in hadronic interaction process at various accelerator energies. The analysis of the experimental data has indicated that the multiparticle production is a two-step process<sup>1-3)</sup> the production of highly excited hadronic states (cluster) which afterwards decay into hadrons. Although there are some interesting hypothesis regarding the nature of the cluster like a) cluster are droplet of gluons or pair of gluons shaken off during the process<sup>2)</sup> b) collective phenomena without dynamical significances<sup>4,5)</sup> c) resonance<sup>6,7)</sup> d)

excited hadronic states<sup>8-10</sup>), still there is no conclusive evidence in favour of any of these theories. Further experimental information, at different energies are needed before one can arrive at some conclusion about cluster.

One can study the presence of clustering in terms of the rapidity ( $Y$ ) distribution of each charged secondary particle produced in an inelastic interaction. The rapidity is defined as

$$Y = \frac{1}{2} \ln \left[ \frac{E + p_{||}}{E - p_{||}} \right] \quad (1)$$

where  $E$  and  $p_{||}$  are the energy and longitudinal momentum of the secondary particles, respectively. For  $p_{||} \gg p_{\perp} \gg m$  ( $p_{\perp}$ ,  $m$  denote the transverse momentum and mass of the secondary particle, respectively), equation (1) becomes  $Y = -\ln \tan \theta/2$ , where  $\theta$  is spatial emission angle of the secondary.

A group of particles will appear to form a cluster if its extension along the rapidity axis is small compared with the total range of rapidity for all of the constituent particles.

This paper presents a study of clustering based on the rapidity space distribution of multiparticle events produced in 300 GeV/c proton-nucleus interaction in emulsion.

## 2. Experimental data

The data have been obtained from the emulsion plates exposed horizontally to the FNAL 300 GeV proton beam<sup>11</sup>. Scanning of these plates were carried out on a Leitz-Ortholux microscope provided with Brower travelling stage. The plates were area scanned under an oil emulsion 53.1  $\times$  objective in conjunction with a 18.8  $\times$  ocular. Every region was scanned by two independent observers and the events were chosen utilizing the criteria i) the beam track must be 3° to the mean beam direction in the pellicle ii) interactions should not be within the top or bottom 20  $\mu$ m thickness of pellicle. All primary beam tracks were followed back to be sure that the events chosen did not include interactions from the secondary tracks of other interaction. The primaries originated from other interactions were observed and corresponding events were removed from the sample. The shower tracks are selected according to the criterion  $b^* < 1.4$  where  $b^*$  is the normalised blob density. Spatial emission angle  $\theta$  for all shower tracks were obtained from co-ordinate measurements (taking four points on shower track and primary track) and hence the rapidity  $Y = -\ln(\tan \theta/2)$  were calculated for all showers.

## 3. Analysis and results

The description of an event in rapidity space can be obtained by ordering the rapidities of each shower of that event as

$$Y_1 < Y_2 < Y_3 \dots \dots < Y_i < \dots < Y_N$$

where  $N$  is the multiplicity of the event. The first rapidity gap or difference is given by

$$\Delta Y_t = Y_{t+1} - Y_t.$$

We select the maximum gap  $\Delta Y_{max}$  and the second-maximum gap  $\Delta Y_{2nd}$  and their corresponding ordinal position or gap number  $i_{max}$  and  $i_{2nd}$  within the rapidity space distribution. Fig. 1 shows the distributed of  $i_{max}$  for  $N = 4, 6, 8$  events.

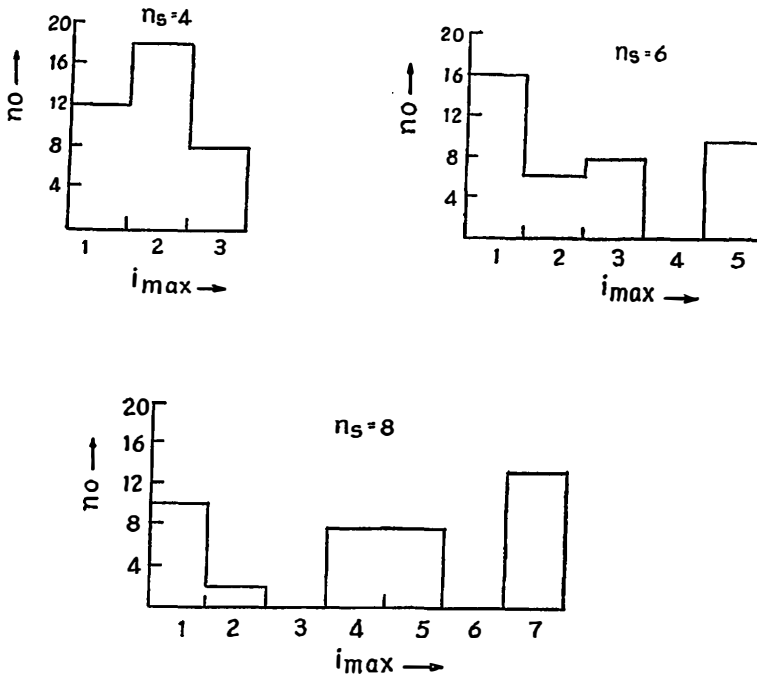


Fig. 1. Distribution of maximum gap number  $i_{max}$  for  $N = 4, 6, 8$  events (as indicated).

Fig. 2 shows the correlation between  $i_{max}$  and  $i_{2nd}$  and Fig. 3 shows the correlation between  $\Delta Y_{max}$  and  $\Delta Y_{2nd}$  for the events with similar multiplicity. The figures speak for themselves. It is observed from Fig. 1 that  $i_{max}$  is either 1 or  $N-1$  even in case of high multiplicity events. This observation agrees with those of Homma et al.<sup>12)</sup> and Ghosh et al.<sup>13)</sup>. The correlation plots are also in quite agreement with the result of Ref. 12, 13 and Adamovich et al.<sup>14)</sup>. It is worth mentioning that these results disfavour the prediction of multiperipheral model according to which the rapidity spacing is expected to be nearly equal i. e.  $\Delta Y_{max} \approx \Delta Y_{2nd}$ . Our results, on the contrary, can be explained in terms of cluster production. One can infer then that multiparticle production in hadron-nucleus interaction at 300 GeV is also a two-step process and proceeds via an intermediate cluster state.

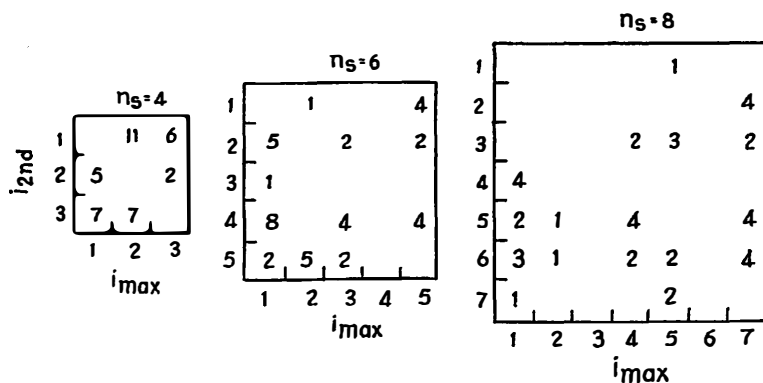


Fig. 2. Correlation plot between  $i_{max}$  and  $i_{2nd}$  for  $N = 4, 6, 8$  event.

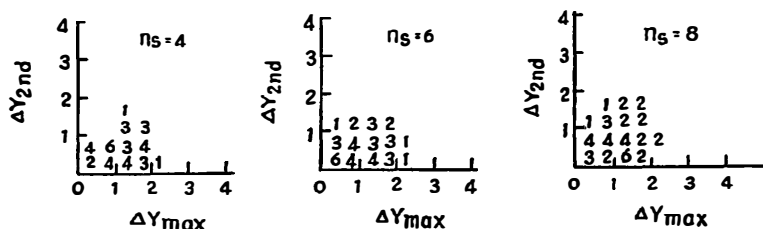


Fig. 3. Correlation plot between  $\Delta Y_{max}$  and  $\Delta Y_{2nd}$  for  $N = 4, 6, 8$  event.

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STUDIJ VIŠEČESTIČNE PRODUKCIJE U INTERAKCIJI PROTON-  
-JEZGRA NA ENERGIJI OD 300 GeV POMOĆU DISTRIBUCIJE U PROS-  
TORU RAPIDITETA

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U ovo je članku iznesena analiza višečestične produkcije u interakciji u emulziji, p-jez a na 300 GeV pomoću distribucije u prostoru rapiditeta. U ovoj je analizi zapaže o da se višečestična produkcija u interakciji protona na jezgrama odvija preko intermedijarnog »klaster« stanja.