ENERGY DEPENDENCE OF TWO PARTICLE RAPIDITY CORRELATIONS IN PROTON-NUCLEUS INTERACTIONS

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In a recent investigation(1) on two particle inclusive correlations in 300 GeV proton interactions on emulsion nuclei, a remarkable asymmetry was found in the $R(\eta_1, \eta_2)$ correlation function. This function shows a clear preference towards higher correlations in the proton-nucleon c.m. backward (or target) hemisphere, whereas in the forward hemisphere its behaviour resembles quite closely the proton-proton case.

In this letter we shall discuss the energy dependence of the correlation functions in proton-nucleus interactions, in order to investigate if this asymmetry effect is maintained as an energy region ($\sim$30 GeV) is reached, where the mechanism of proton-nucleus interaction is described in a quite different way from the high energy regime(2).

The present analysis is based on some 1200 proton interactions on emulsion nuclei, at 27,200 and 300 GeV(*), characterized by a number N_h of heavy tracks (i.e. the evaporation particles emitted in the inter-

*) 27 GeV data were obtained from emulsion plates exposed at CERN proton-synchrotron(3); 200 and 300 GeV data were assembled in the Barcelona-Batavia-Belgrade-Bucharest-Lund-Lyons-Montreal-Nancy-Ottawa-Paris-Rome-Strasbourg-Valencia Collaboration(4). We would like to thank all our collaborators for use of the commonly scanned material.

action) not exceeding one. This class of events ($N_h \leq 1$) showed the strongest asymmetry effect in the R-function in the quoted 300 GeV analysis. Coherent production events were not removed, but their contribution is small and they cannot affect our conclusions.

The inclusive single particle distributions obtained from our sample of emulsion stars is shown in Fig. 1. Here we use the laboratory pseudorapidity variable for it allows a direct comparison among the different energies. No dependence is shown in the target fragmentation region but there is an increase in the width of the distributions from 27 to 300 GeV, as it can be expected from the relevant pp distributions.

The correlation functions we choose for our analysis are the widely used $R(\eta_1, \eta_2)$ and $C(\eta_1, \eta_2)$[5], where η_1 and η_2 are the pseudorapidities of the pair of charged particles in the c.m. proton-nucleon frame. In proton-proton interactions these functions give similar information and the choice of one of them is often due only to technical reasons. However, in proton-nucleus interactions, owing to the observed asymmetry, the use of both them can give a somewhat different understanding and in some cases complementary informations. Indeed we observed[6] a different behaviour of $R(\eta_1, \eta_2)$ and $C(\eta_1, \eta_2)$: the latter shows an increasing asymmetry with nuclear excitation, whereas the former is strongly asymmetric for any N_h value.

Fig. 2 shows the correlation functions $R(\eta_1, \eta_2)$ and $C(\eta_1, \eta_2)$ along the $\eta_1 = \eta_2$ diagonal. Clearly the asymmetry already observed at 300 GeV is still evident at 200 GeV and even at 27 GeV, whatever function is used. It is to be noted that the R function is growing from 27 to 200 GeV, but shows no appreciable change between 200 and 300 GeV. The C function is not so strongly asymmetric as the R function, nevertheless it confirms the nuclear effect on correlations. Moreover it shows an energy dependence stronger than $R(\eta_1, \eta_2)$,

making the difference still evident between 200 and 300 GeV. This fact could be connected to the rather strong dependence of $C(\eta_1, \eta_2)$ on the number of emitted particles, observed in pp interactions[7], and the rise of the average multiplicity with energy.

In conclusion, we find that the asymmetry of two particle correlations, observed at 300 GeV, is clearly exhibited down to low energies (27 GeV), where both theoretical description and available data claim a different production mechanism. Although the amount of correlation shows some energy dependence from 27 to 200÷300 GeV, the high positive values of $R(\eta_1, \eta_2)$ and $C(\eta_1, \eta_2)$ are always shifted towards the $\eta < 0$ region.

Therefore this tendency of emitted hadronic matter to be more correlated in the target hemisphere is just characteristic of proton-nucleus interaction in a wide energy range.

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5) For the definition of $R(\eta_1, \eta_2)$ and $C(\eta_1, \eta_2)$ see for example R.Slansky, Physics Reports 11C (1974) 99.

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FIGURE CAPTIONS

Fig1 - Inclusive laboratory pseudorapidities distributions at 27,200 and 300 GeV for $N_h \leq 1$ emulsion stars.

Fig. 2 - Correlation functions, a) $R(\eta_1, \eta_2)$ and b) $C(\eta_1, \eta_2)$, along the diagonal $\eta_1 = \eta_2$ at 27,200 and 300 GeV for $N_h \leq 1$ emulsion stars.

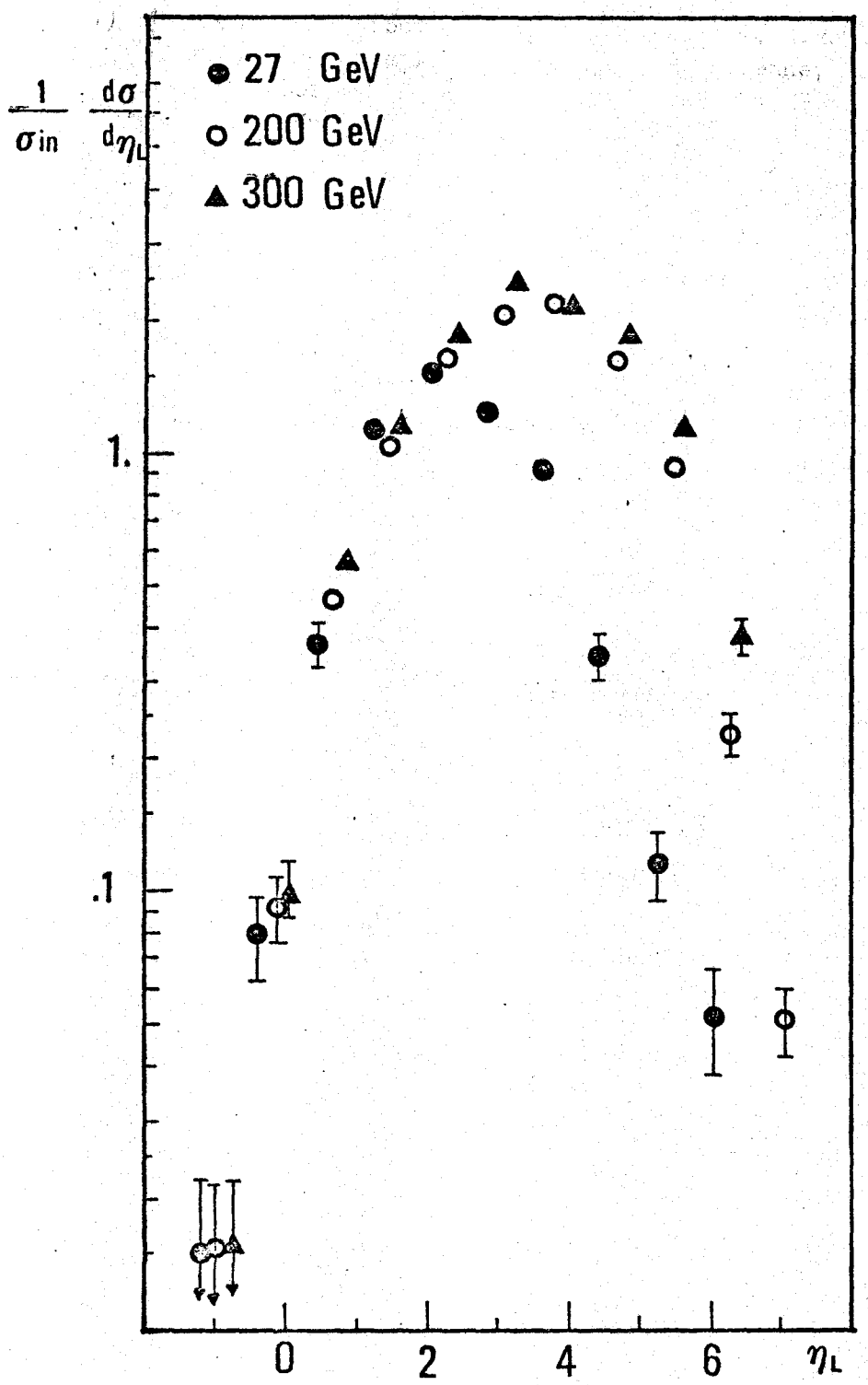
$\frac{1}{\sigma_{in}} \cdot \frac{d\sigma}{d\eta_L}$
27 GeV
200 GeV
300 GeV
1.
.1
0
2
4
6
η_L

Fig.1

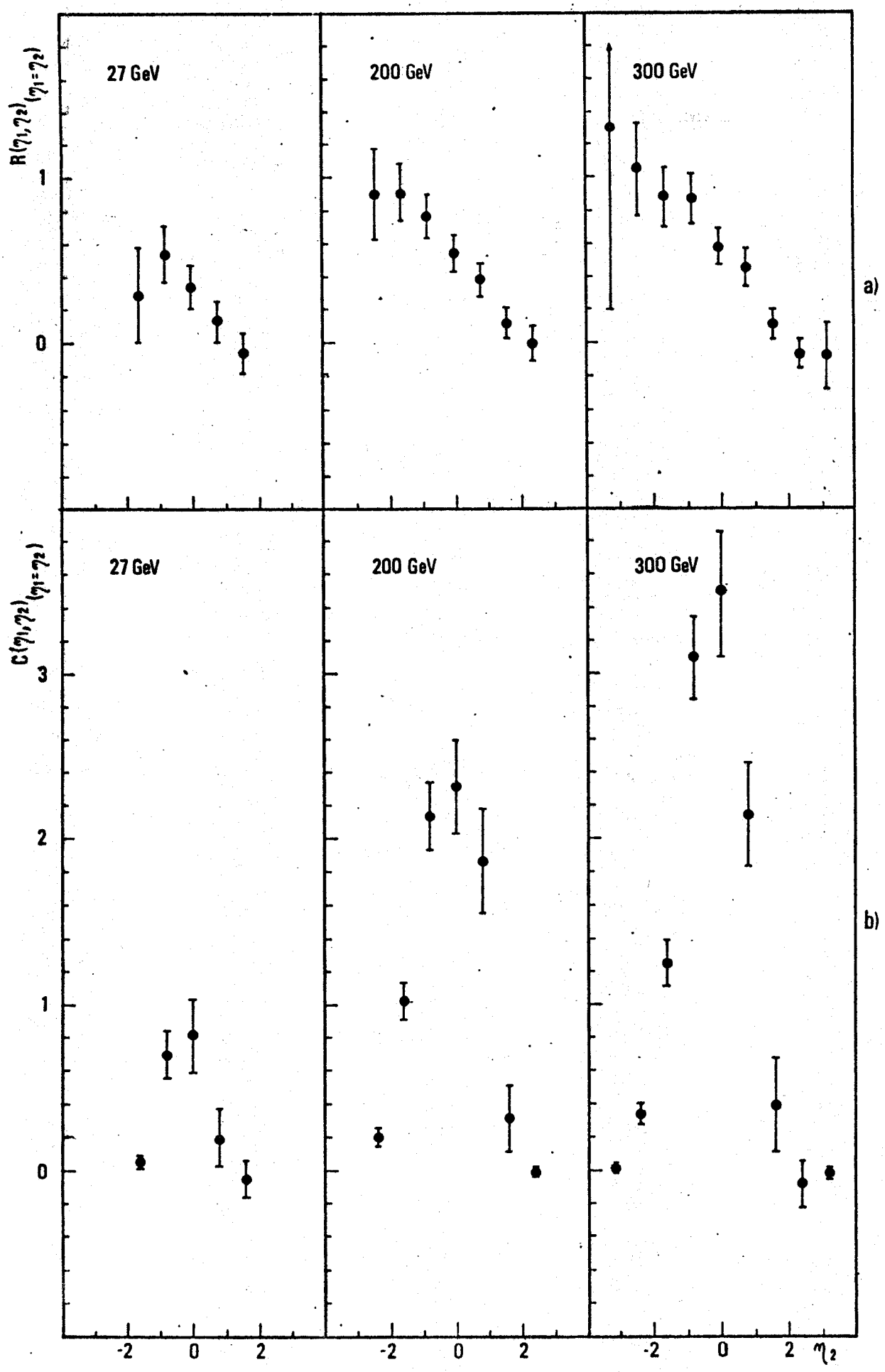
27 GeV
200 GeV
300 GeV
$R(\eta_1,\eta_2)_{(\eta_1=\eta_2)}$
a)
$C(\eta_1,\eta_2)_{(\eta_1=\eta_2)}$
b)
η_2

Fig.2