TWO PARTICLE CORRELATIONS
IN ANTIPROTON – PROTON INTERACTIONS AT 5.7 GeV/c

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Results for two-particle correlation in $\bar{p}p$ interactions at 5.7 GeV/c are reported and their
significance discussed within the framework of current phenomenological models of multi-
particle production.

1. INTRODUCTION

In a recent paper [1] I have reported results of a systematic study of single-particle
inclusive distributions of charged particles in $\bar{p}p$ interactions at 5,7 GeV/c. In this
note I complete the inclusive analysis of 5.7 GeV/c data by discussing certain aspects
of two-particle correlations.

The data sample comes from the exposure of CERN 2 meter HBC to a separated
beam of antiprotons at 5.7 GeV/c. The details of the experimental procedure are dis-
cussed in [2]. Here I want to address two particular questions:

a) semiinclusive rapidity correlations,
b) correlations in azimuthal angle.

Both of these subjects contain important information about the dynamics of $\bar{p}p$
interactions and are therefore discussed in most analysis dealing with inclusive
particle production. As far as a) is concerned what turns out to be most interesting
is the energy dependence of inclusive rapidity distributions. This is in particular
also the main prediction of the Mueller-Regge approach to inclusive reactions [3].
The observation of nontrivial dynamical correlations in rapidity is usually interpreted
in terms of clusters or other objects, which are primarily produced in collisions and
which subsequently decay into the observed particles. While some of their properties
can be deduced already from the single-particle distributions, only the study of two-
particle correlations can unambiguously reveal their presence. As these objects
may be very heavy, their mass being of the order of several GeV/c$^2$, it is important
to understand the threshold behaviour connected with their production. For this
purpose the "low" energy data in the range 5–10 GeV/c of primary momentum
are essential. Our results indicate convincingly that in this range there are no signi-
ificant dynamical correlations of the kind mentioned above.

This, however, still does not mean that there are no dynamical correlations in our
data at all. First, in the analysis of rapidity correlations (point a) we have averaged
over the azimuthal angle and thus lost some subtle information. Secondly, because

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of the heavy combinatorial background in multiparticle final states, the influence of low mass ordinary resonance \((q, \omega, \phi)\) can be effectively masked. A more promising way to reveal their presence is a study of azimuthal correlations of pairs of identical particles. Such correlations were observed at both high [4] and low [5] energies and are present in our data, too. In spite of a rather extensive study of azimuthal correlations in recent years, their origin is still far from clear. Some authors [6] consider them a consequence of ordinary resonances while others find in their data more support for the influence of the so-called Bose-Einstein effect [7].

In my opinion the progress in both mentioned aspects of two-particle correlations will come only through accumulation of yet more and better data and their analysis within a single theoretical framework. For this purpose even our low energy data can be of interest.

The paper is organized as follows. In the next section I will discuss the rapidity correlations in semiinclusive reactions and compare them with expectations of the Mueller-Regge approach. Azimuthal correlations are dealt with in the third section and a short summary followed by a discussion of the implications of our results can be found in the concluding, fourth section.

2. RAPIDITY CORRELATIONS IN SEMIINCLUSIVE REACTIONS

Let me first define the relevant notation. Then \(n\)-particle inclusive reactions are processes of the type

\[
(2.1) \quad a + b \rightarrow c_1 + c_2 + \ldots + c_n + \text{anything}.
\]

In our case \(a = p, b = p\) and \(c_i\) are particles under study. In the preceding paper [1], I had discussed the case of single-particle inclusive reactions, i.e. \(n = 1\). Here I proceed to two-particle inclusive reactions. The analysis presented in this paper is, however, not a complete study of two-particle inclusive reactions, but is carried out with a rather definite aim in mind.

The reasons for introducing this way of analyzing collisions of elementary particles are twofold. First, with the growing primary energy and resulting increase of the number of final state particles, it becomes increasingly difficult to isolate and fully kinematically analyze all the exclusive channels, i.e. such final state configurations in which all particles are unambiguously identified. In this respect inclusive reactions (2.1) make virtue out of necessity. Secondly, while in general it would certainly be better first to identify all the exclusive channels and then, by simple integration over the unobserved particles, to determine the inclusive cross-sections, there are circumstances when this procedure brings no advantage at all. Specifically there may be features of final states that are common to many of them. The inclusive (or semi-inclusive, see below) analysis (2.1) is then more appropriate both from experimental (higher statistics) and theoretical points of view. Two-particle correlations are an example of such a feature.