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Probable "colorball" production in pp-collisions at 450 GeV/c

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Abstract

Baryon-antibaryon production in pp-collisions at 450 GeV/c seen by the CERN-collaboration WA102 is discussed in terms of an intermediate non-resonant "colorball".

1. Introduction

A motivation for the CERN-project WA102 was that central production has been proposed to be a good place to produce glueballs via double pomeron exchange [1]. The WA102 collaboration has reported baryon-antibaryon production in the central region of the reaction

$$pp \to pXp \tag{1}$$

at 450 GeV/c, where X is one of the four systems $\Lambda\bar{\Lambda}$, $p\bar{p}$, $p\bar{p}\pi^0$ or $p\bar{p}\pi^+\pi^-$ [2]. Since no resonance production was seen for any X, no glueball candidate was found in these final states. These four final states, one with and three without starnge particles, have six characteristic features in common:

a) Every X is centrally produced according to tests on rapidity [2], oresumably by double exchange processes.

b) The energy dependence of production cross sections (not measured for $p\bar{p}\pi^0$) excludes double pomeron exchange, but no alternative exchange and production mechanism was identified [2, 3].

c) A slope parameter $b \approx 5$ GeV^{-2} of the distribution of fourmomentum transfer t at a proton vertex [2] (which one is not specified in [2]).

d) A "flat" distribution of the azimuthal angle ϕ between the transverse momentum vectors of the two final state protons [2, 4].

e) A ratio $R \approx 1/3$ between the number of events observed for $dp_t < 0.3$ GeV/c and for $dp_t > 0.5$ GeV/c, respectively, where dp_t is the numerical value of the difference between the transverse momentum vectors of the two final state protons [2, 5], in disagreement with double pomeron exchange and with exchanges with a gluonic component.

f) Background-like distributions of effective mass enhanced towards minimum mass for every X, i.e. no resonance production is seen for any X [2].

2. Comments

That four final states have six observed characteristic features in common as described above suggests that one common process produces these four final states.

Also, since every X, e.g. $X = p\bar{p}$, is centrally produced, every X is probably a final state of a common intermediate system S produced in a double peripheral pp-reaction by two exchanges y and z, i.e.

$$y + z \rightarrow S \rightarrow p + \bar{p} \tag{2}$$

as shown in Fig. 1.

Furthermore, since the assumed S has two main decay modes, with or without strangeness, S has probably received only colors and anticolors but no flavours and antiflavours from the exchanges y and z.

3. The Intermediate System

We now assume that S is an intermediate "colorball" without quarks and antiquarks, but with e.g. these colors and anticolors,

$$r,\ b,\ g,\ \bar{r},\ \bar{b} \text{ and } \bar{g},$$

which may form two separate colour singlets, i.e.

$$S(rbg\overline{rbg}) \rightarrow B(rbg) + A(\overline{rbg}), \tag{3}$$

where $B(rbg)$ is a baryonium [6] and $A(\overline{rbg})$ an antibaryonium, respectively, both without quarks and antiquarks. These two colour singlets hadronize to a baryon and an antibaryon, i.e.

$$B(rbg) + A(\overline{rbg}) \rightarrow baryon(q^r q^b q^g) + antibaryon(\bar{q}_r \bar{q}_b \bar{q}_g) \tag{4}$$

where a quark q in this context is a u-, d- or s-quark, and where the superscripts and subscripts symbolize colour and anticolour, respectively. If these two final state systems are excited and decay, or if S contains additional colours and anticolours which hadronize, additional mesons may also be produced.

4. The Exchanges

Since double pomeron exchange and exchange of mesons which could have a gluonic component are inconsistent with the experimental data [2], and since exchange of quark-antiquark mesons is unlikely because of strange- and non-strange decay modes of the assumed intermediate system, other types of exchange are probably responsible for the reactions (1).

Exchanges which can supply the assumed intermediate state with the colors and their anticolors needed for the recombination mechanism discussed above are requested by our model. Since the colliding protons can not change their colors, exchange of "colorballs" with e.g. two colors and their anticolors would fulfil the requirements in this context. If so, their characteristic features would be those found experimentally by WA102 [2].

5. Conclusion

If, in a double peripheral process with particle production in the central region, the exchanges do not carry flavour and antiflavour while the produced particles do, then an intermediate system and the exchanges behave as "colorballs".

Therefore, if we assume that the exchanges behave as "colorballs" which carry those colors and their anticolors which via an intermediate "colorball" recombine to two color singlets which hadronize to a baryon-antibaryon pair, a possible and because of its simplicity likely model for baryon-antibaryon production in the central region of high energy pp-reactions appears.

If such a "colorball", which is assumed to be a system of colors, should be equivalent to a glueball, which is an assumed system of gluons, then a glueball could not be a resonance.

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Figure

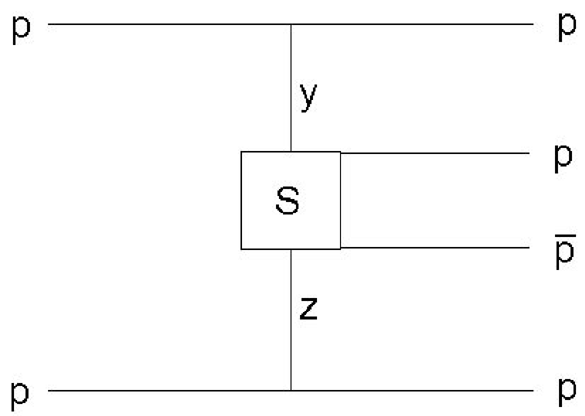

Fig. 1
The reaction $p + p \to p + (p + \bar{p}) + p$ in terms of a double peripheral diagram.