ANALYSIS OF THE ANNIHILATION REACTION $\bar{p}p \to 2\pi^+2\pi^-$ at 3.6 GeV/c IN TERMS OF A MULTI-PERIPHERAL MODEL INCLUDING RESONANCES

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SUMMARY OF THE COMMUNICATION

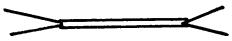
The annihilation reaction $\bar{p}p \to 2\pi^+2\pi^-$ at 3.6 GeV/c appears to proceed through 9 intermediate channels involving meson resonances ρ^o, f^o, g^o. The multi Regge model of Chan-Loskiewicz and Allison (CLA), which is found to give a good description of pion distributions, such as c.m.s. angles and momenta, is inadequate for resonance formation. The introduction of resonances in the CLA model made by Plathe and Roberts leads to a rather poor description of the data and give no information on the branching ratios of the intermediate states. So we attempt to introduce the resonances in the CLA model by considering that they can be coupled to the nucleon Regge trajectory in the same way as pions through phenomenological coupling constants. Then, the amplitudes of all the multi-peripheral graphs that can be drawn are added incoherently.

This phenomenological model introduces one extra parameter/resonance relative to the original CLA model. It may be extended to higher multiplicities.

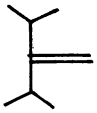
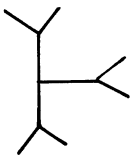
We found that this sum of amplitudes approximates well the physical situation at 3.6 GeV/c, equally well for pions and multi-pions distributions as for resonance formation. A straightforward extrapolation of the model to 1.2 and 5.7 GeV/c leads only to minor discrepancies.

DISCUSSION AND COMMENTS

Mr. Bizzari : According to duality it is illegitimate to add diagrams like

 and 

Now you propose to add diagrams like

 and 

I wonder if this is consistant with duality ?

Mr. Butterworth : (to Mr. De La Vassière) How well do you fit the 3-body mass in the 4-body channel ?

Mr. De La Vassière : Very Well. (A slide was shown).

Mr. Butterworth : About the analysis of the $\pi^+\pi^-$ S-wave in $\bar{p}p \to \omega\pi\pi$, how do you get rid of the ρ ?

Mr. Montanet : $\bar{p}p \to \omega\rho$ comes from $^1S_0$, it does not interfere with $^3S_1$ initial state which is contributing to the final state with a $\pi^+\pi^-$ S-wave.

Mr. Armenteros : How do your results compare with those of Baton ?

Mr. Butterworth : Are you saying that you can exclude the so-called up-down solution ?

Mr. Ghesquière : The last results for the $\pi^+\pi^-$ S-wave parametrization, as observed in $\bar{p}p \to \omega^o\pi^+\pi^-$, give the following results for the parametrization of the $\pi^+\pi^-$ S-wave:

1) assuming a slowly varying inelasticity, δo^o goes from 90^o at 840 MeV to 270^o at $\sim$ 1000 MeV, via 180^o at 940 MeV;

2) or, assuming δo^o to be close to 90^o in the mass range 800-1000 MeV, the inelasticity parameter has a rapid decrease immediately followed by a rapid increase around 940 MeV.

For more details, see the article "$\omega\pi$ resonances and $\pi\pi$ S-wave structures as observed in $\bar{p}p$ annihilations at rest" - P. Frenkiel, C. Ghesquière, E. Lillestol, S.U. Chung, J. Diaz, A. Ferrando and L. Montanet - CERN/D.Ph.II/PHYS 72-9.

So, you see that we find two possible solutions : in terms of the usual terminology, we could say that we favour the down-up and the down-down solutions (with a sharp absorption at 940 MeV in the last case).

Mr. Kalogeropoulos : We observe also a dip in $\pi^+\pi^-$ at 970-980 MeV for $\bar{p}n \to 4\pi$ at rest (16 000 events).

Mr. Ghesquière : The dip observed in $\pi^+\pi^-$ for $\bar{p}p \to \omega\pi^+\pi^-$ is also observed in $\pi^+\pi^-$ for $\bar{p}p \to \rho\pi^+\pi^-$. See : J. Diaz, Ph. Gavillet, G. Labrosse, L. Montanet, W. Swanson, P. Villemoes, M. Bloch, P. Frenkiel, C. Ghesquière, E. Lillestol, A. Volte - Nuclear Physics - B 16 (1970) 239.

Mr. Moneti : What is the relationship between the parametrization used by Bizzari et al. for the dip in the $\pi^+\pi^-$ mass distribution in the $\omega\pi\pi$ state, and the description of a very similar phenomenon observed by Flatté et al. in the $\pi\pi$ system ?

Mr. Ghesquière : Flatté's solution is quite close to our second solution, with inelasticity opening abruptly at some value. Our dip is a bit lower (950 instead of 990 MeV).

Mr. Fridman : Mr. Ghesquière said that the symmetrization procedure in $\bar{p}p$ annihilation processes can explain the Goldhaber effect. I do not think that this is true and this for two reasons :

- This model does not take into account the resonance production;
- The symmetrization as used by experimentalists is not always made in a correct way because the constraints due to the initial isospin are not taken into account. See a paper by Pais on the subject.

Mr. Ghesquière : I have been a little rough in saying that B.E. symmetrization explains all of Goldhaber's effect. We have to introduce resonance production.

Mr. Kalogeropoulos : It is clear that Goldhaber's effect is not only a question of B.E. symmetrization. But the application of symmetrization always goes in the right direction (decreases χ^2, for instance).

Mr. Donald : Regarding the effect of parametrizing the Goldhaber effect, one can see effects in the mass plots e.g. in $\pi^+\pi^+$ masses. It also tends to alter fractions obtained from simple incoherent Breit-Wigner-type fits. For instance, the amount of single ρ production is reduced and the amount of phase-space increased.

Mr. Kalogeropoulos : (to Mr. Muirhead) Some time ago, you published a comparison between the mass plots of like and unlike pion pairs. Could you account for the difference in terms of symmetrization.

Mr. Muirhead : Our analysis of $\pi^+\pi^+$ and $\pi^-\pi^-$ mass correlations was not satisfying, as the system we examined had too many particles.

It is worth noting that the CLA model satisfactorily reproduces the opening angles for $\pi^+\pi^+$ and $\pi^+\pi^-$.

Mr. Allison : There is a very significant effect in mass plots corresponding to the Goldhaber effect. It covers the range 280-380 MeV in mass (data was shown).

Mr. Armenteros : I have seen a paper by the K^+ collaboration about high multiplicity K^+ interactions. They see correlations which are the opposite of what you expect from B.E. statistics. For more details contact Mr. Goldschmidt-Clermont.