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LETTER OF INTENT TO STUDY dd INTERACTIONS AT 14 GeV/c BY MEANS OF 400,000 PICTURES IN THE 2m DBC

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Summary.-

We are now peparing a proposal to study dd collisions at 14 GeV/c. This letter of intent should be considered as expressing our firm intention to carry out this experiment. We intend to investigate the following reactions:

$$dd \rightarrow dd\, m\pi$$

$$dd \rightarrow N_s d\, m\pi$$

$$dd \rightarrow N_s N_s\, N\bar{N} m\pi$$

The main physics points which we want to study are exposed below.

1. INTRODUCTION

We are now writing a detailed proposal for studying dd collisions at 14 GeV/c. This preliminary report, however, should be considered as expressing our firm intention to proceed with the study of dd interactions. Our final proposal will be send to the TCC during the coming weeks. The main physics points which we want to study are exposed briefly below. They are divided in the following sections :

- Interactions with two deuterons in the final state.
- Interactions with one deuteron in the final state.
- Multiplicity distributions and statistical moments.
- NN interactions.

2. INTERACTIONS WITH TWO DEUTERONS IN THE FINAL STATE

The dd → ddmπ reactions will allow us to investigate the I = 0 mπ system. In the case of the dd → dd$\pi^+\pi^-$ channel we can thus obtain information on the I = 0 ππ interactions (the cross section for the dd$\pi^+\pi^-$ final state is estimated to be ~ 30 μb, corresponding hence to 500 events ; see Table I). In general by using the dd → ddmπ reaction one can also study any (m - 1)π system which, because of isospin conservation, is constrained to have the isospin I = 1. We also intend to study the d^* (or double d^*) production and the d → dmπ diffraction dissociation process. Apart of the m = 1 case at 3 and 7.9 GeV/c[1,2] nothing is known on the value of the dd → ddmπ cross section. Therefore the measurement of these cross section alone can already be considered as an interesring task.

3. INTERACTIONS WITH ONE DEUTERON IN THE FINAL STATE

The present experiment is particularly suitable for studying events with one deuteron in the final state as we are obtaining in the same time nd and pd reactions. In these cases, one among the four incoming nucleons is a spectator one. Thus we will be able to investigate the reactions

$$nd \rightarrow (p_s)p\,d\,m\pi^+(m+1)\pi^- \qquad (1) \qquad m \geq 1$$

$$pd \rightarrow (n_s)p\,d\,m\pi^+m\pi^- \qquad (2)$$

the former belonging to the class of four constraint reactions.

The reactions (1) have also the interesting properties that the $(m+1)\pi^-(m-1)\pi^+p$ subsystem is in the pure $I = 3/2$ isospin state. Thus a study of the $I = 3/2$ baryonic resonances can be carried out.

With respect to the usual pd interactions the dd collisions enhance the number of events in some of the reactions in which a deuteron appears in the final state. Indeed because of the charge symmetry invariance the $nd \rightarrow (p_s)ndm\pi$ events can be added to the $pd \rightarrow (n_s)\ pdm\pi$ $(m > 1)$ events. Then if α is the possibility that one of the incident bound nucleon strikes the other incoming deuteron so that it remains unbroken after the collision, the probability to observe an outgoing d in dd collisions for the reactions just mentioned is $2\alpha(1-\alpha)$. As α is small one obtains nearly twice as much d in dd collisions than with pd collisions. Therefore in addition to the possibility to study the $Nd \rightarrow Nd\,m\,\pi$ reactions the present experiment is particularly well adapted for investigating the inclusive $dd \rightarrow dX$ process.

4. MULTIPLICITY DISTRIBUTIONS AND STATISTICAL MOMENTS

Recently a great deal of stimulating works have been made on multiplicity distributions. In particular multiplicity distributions have been studied on complex nucleus[3]. We intend here to study the multiplicity distributions as well as the statistical moments obtained in dd collisions. A comparison will be made with pd and NN interactions at the same c.m. energy.

5. STUDY OF NN INTERACTIONS

The present experiment will also allow us to study the NN collisions although the presence of two spectator nucleons will complicate the data analysis. Nevertheless the reaction $nn \rightarrow ppm\pi$ presents a great interest as the outgoing $m\ \pi$ system is in a pure isospin $I = 2$ state. It will then be possible to make a systematic search for $I = 2$ boson resonance for which some evidence have been reported some years ago.

6. CONCLUSIONS

As discussed above the proposed experiment will allow us to study subsystems produced in definite isospin states. The states to which one has access can be summarized as follows :

$dd \rightarrow dd\, m\pi$	$I[m\pi] = 0$ and $I[(m-1)\pi] = 1$
$Nd \rightarrow Nd\, m\pi$	$I[N,n\pi] = 1/2$
$nd \rightarrow p\, d\, m\pi^+(m+1)\pi^-$	$I[(m-1)\pi^+,(m+1)\pi^-,p] = 3/2$
$nn \rightarrow p\, p\, m\, \pi$	$I(m\pi) = 2$

In Table I we give estimates of cross sections and the corresponding number of events for some specific channels. The cross sections for reaction (1) was obtained by assuming that it is nearly incident momentum independent as suggested by dd data obtained at 3 and 7.9 GeV/c[1,2]. For reaction (2) through (4) we estimated the various cross sections using our $\bar{p}d$ experiment at 9 GeV/c[4] since the $\bar{p}d$ and pd coherent reactions appear to be nearly equal[5,6]. The values for (5) has to be considered only as a rough guess as we used factorization in a c.m. energy where its validity is rather dubious.

References

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TABLE I - Rough estimates of cross sections and number of events for some specific channels. The number of events were calculated using 10 d per pictures and 400,000 photographs

reaction	cross section (mb)	number of events
$dd \rightarrow dd\pi^+\pi^-$	0.03	~ 450
$dd \rightarrow N_s ddm\pi$	> 3,0	> 44,500
$dd \rightarrow N_s Nd\pi^+\pi^-$	0,3	4,400
$dd \rightarrow p_s pd\pi^-$	0.9	~ 12,000
$dd \rightarrow p_s p_s pp\pi^-\pi^-$	~ 2.5	36,000