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PHYSICS I

ELECTRONICS EXPERIMENTS COMMITTEE

EXTENSION OF THE $K^-p \rightarrow \overline{K}^on$ EXPERIMENT TO STUDY $\bar{p}p \rightarrow n\bar{n}$ FROM 1 TO 3 GeV/c AS AN INVESTIGATION OF BOSONS WITH MASS BETWEEN 2.08 AND 2.78 GeV

by

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This is a letter indicating an experiment of considerable physics interest which can be performed with the present beam m 7 and the same equipment which will perform the $K^- p \rightarrow \bar{K}^o n$ experiment. The changes in the system required for the $\bar{p}p \rightarrow n\bar{n}$ experiment are:

a) tuning the beam to separate $\bar{p}$ from K^-, π^-,

b) changing Cerenkov gas pressures,

c) changing timing of the beam-defining counters.

We could perform this experiment immediately after the $K^- p$ experiment is completed. In any case, the experiment can be done at any other time in the future as the equipment is ready and can easily be installed.

The data on the total $\bar{p}p$ cross section of Cool et. al.[1] strongly suggests that the $\bar{p}p$ entrance channel is coupled to the bosons in this mass range. It may be noted that the magnitude of the structures observed by Cool were of the order of 2 mb sitting on top of the total $\bar{p}p$ cross section which fell from 115 mb to 76 mb in the 1-3 GeV/c range. The charge exchange $\bar{p}p \rightarrow n\bar{n}$ partial cross section is roughly constant and about 6 mb in the same energy range. At present there are a few bubble chamber measurements of the charge exchange cross section to an accuracy of ± 25 % in this range. It is very plausible that s-channel effects are playing an important role in the charge exchange reaction just as they are in the $K^- p \rightarrow \bar{K}^o n$ reaction. In fact, the 2 mb fluctuations seen by Cool et. al. may well be dominant features in the charge exchange process.

Finally, we should note that the next recurrence V, of the boson states R, S, T, U should occur at 2.63 GeV corresponding to 2.55 GeV/c $\bar{p}$ momentum which is within the range of our proposed investigation. A major objective of our experiment would be to discover resonant structure at this energy.

It should be mentioned that Good et. al.[2] at Brookhaven have proposed an experiment to look near 0^o and 180^o in $\bar{p}p \rightarrow n\bar{n}$ for structure in the same energy range. This experiment will not take place until late next year. Existing experiments on channels like $\bar{p}p \rightarrow \pi^+\pi^-$, K^+K^- and $\bar{p}n \rightarrow \bar{p}n$ are, for the most part, bubble chamber experiments and are very limited by statistical accuracy. We regard an accurate (1% statistical accuracy at 50 MeV/c steps) counter measurement of the $\bar{p}p$ charge exchange cross section as a sensitive probe of heavy meson states and certainly complementary to all previous and proposed experiments that we are aware of.

Passing now to the technical part, the idea is identical to the K^-p experiment in that all final states, other than the one of interest, will be detected by the counters surrounding the 50 cm liquid hydrogen target. There is one exception to this statement, namely $\bar{p}p \rightarrow K^o\bar{K}^o \rightarrow K_2^o K_2^o$. Bubble chamber data[3] indicate that this channel will be < 1 % of the $n\bar{n}$ channel.

The Cerenkov counters will be used together with time of flight information to identify $\bar{p}$ in the beam. The corrections will be similar to those in the $K^-p \rightarrow \bar{K}^on$ experiment.

An estimate of the required time can be made as follows. We assume 30 % of the P.S. beam at 27 GeV/c with an average intensity of 9×10^{11} protons per burst. Our beam at 2 GeV/c and $\pm 1\%$ $\Delta p/p$ will then contain approximately 5×10^3 $\bar{p}$ per machine burst (2.7 sec repetition rate). With the 50 cm long hydrogen target and a 6 mb cross section we obtain 60 charge exchange events per burst. Due to neutron and anti-neutron interactions in the detectors surrounding the target, the observed rate will fall to about 40 events/burst. Thus 12 minutes will be required for a 1% statistical accuracy. Tuning the beam to the next desired momentum will also be a 10 - 15 minute operation. Thus about 25 minutes will be required for a single measurement at 2 GeV/c. At 1 GeV/c the time required for a single measurement will increase to about 3 hours due to the reduced antiproton flux. Above 2 GeV/c the time per measurement may be about 20 minutes. Thus the overall time required for the 40 measurements performed at 50 MeV/c intervals between 1 and 3 GeV/c is about 40 hours. Allowing for a 50% overall efficiency factor,we arrive at 80 hours machine time. In practice, one week of P.S. time should allow enough time for the change-over from the K^-p experiment, for the tune-up of the system and the taking of the data.

We might note that the mass resolution in this experiment is about 16 MeV full width at 2.4 GeV boson mass. This is due almost entirely to the ± 1% $\Delta p/p$ of the incident antiproton beam. If evidence of structure were found, say, at 2.4 GeV, then the momentum interval of the $\bar{p}$ beam could be reduced and the resolution brought down to the limit due to the ionization loss in the target, i.e. $\sim$ 6 MeV full width.

To summarize, we propose that with one week of P.S. time we measure the $\bar{p}p \rightarrow n\bar{n}$ charge exchange cross section in the range 1 - 3 GeV/c at intervals of 50 MeV/c to 1 % statistical accuracy and with a mass resolution of about 16 MeV. We believe this would prove to be a sensitive probe of bosons in the range 2.08 - 2.78 GeV.

We might add finally that in a second week of machine time we could extend the measurements to the range 0.5 - 1.0 GeV/c where there are also indications[4] of resonant structure in the $\bar{p}p$ system.

References

(1) R.L. Cool et al., Phys. Rev. Letters 16, 1228 (1966).

(2) M.L. Good et al., Proposed Experiments at the A.G.S. Dec. 1967.

(3) Armenteros et al., Proc. Int. Conf. on High Energy Physics 1962, p. 355.

(4) D. Cline et al., University of Wisconsin, Preprint submitted to Vienna Conference, Sept. 1968.

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