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PP CHARGE EXCHANGE SCATTERING BELOW 1.1 GeV/c

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$\bar{P}P$ CHARGE EXCHANGE SCATTERING BELOW 1.1 GeV/c

Robert D. Tripp

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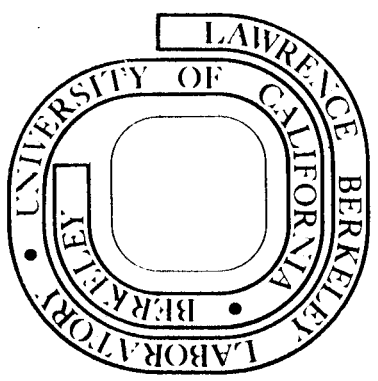
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PP CHARGE EXCHANGE SCATTERING BELOW 1.1 GeV/c

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A precision counter measurement of the energy dependence of the total cross section for the reaction $p\bar{p} \rightarrow n\bar{n}$ has recently been published (1). These results are shown in Fig. 1. We found no significant structure in the region of the S(1935) meson where substantial bumps are seen in the total (2) and elastic cross sections (3). The implications of these measurements with respect to the quantum numbers of the S meson(s) have been reviewed in this session by Eisenhandler. I shall not dwell further on this but instead shall indulge in some wishful thinking as to how the experiment might be improved and extended.

Figure 2 shows the apparatus used in the above experiment. It should be understood from the outset that the apparatus was designed to study the reaction $K^-\bar{p} \rightarrow \bar{K}^0 n$. The major defect for low momentum \bar{p} studies is that, in passing through the 40 cm hydrogen target, the \bar{p} ionization loss in the region of the S meson corresponds to an 18 MeV change in the cm energy. This is approximately twice the measured width of the S meson, leading to unnecessary loss in sensitivity. A 10 cm target would have been more appropriate for studies of narrow resonances. Another easily improved defect concerns the Pb-scintillator sandwich surrounding the charged particle veto counters. Its function is to signal the presence of γ rays, thereby eliminating the multi- π^0 annihilations which compose about 25% of the all-neutral final state, the remainder being the charge-exchange reaction of interest. Since the average number of γ rays expected from these annihilations is 7.7 (4), rather less lead is necessary than was actually used, thus reducing the substantial (30%) corrections for \bar{n} and n interactions in the veto box. Furthermore since no \bar{n} or n are emitted beyond 83° to the beam direction, the γ ray veto could be concentrated in the backward hemisphere where no neutrons emerge.

A new low energy separated beam is expected to come into operation at BNL next year (5). With 5 times the solid angle acceptance of the present beam, fluxes of about 3000 \bar{p} /pulse can be expected at 500 MeV/c. Such intensity would make feasible the measurement of the charge-exchange differential cross section as well. It would be of particular interest to study carefully the energy dependence of the forward and backward differential cross sections.

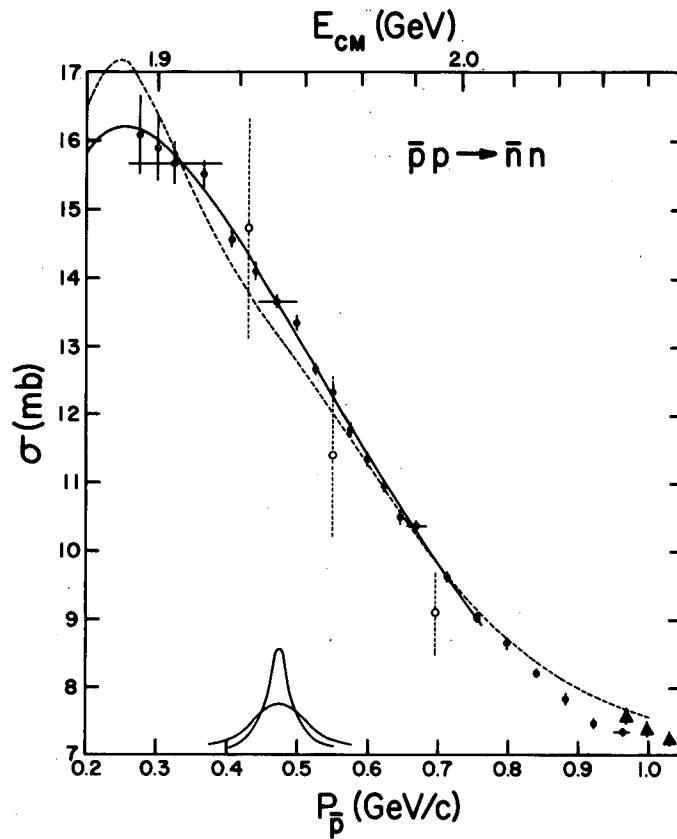


Fig. 1. Cross section for the reaction $\bar{p}p \rightarrow \bar{n}n$ versus lab momentum. The closed circles are from this experiment while the open circles are bubble chamber points. The solid curve is a three parameter fit to the data and the dashed curve is a theoretical potential model calculation of Bryan and Phillips. Neither contain the resonance at 1935 MeV shown at the bottom of the figure.

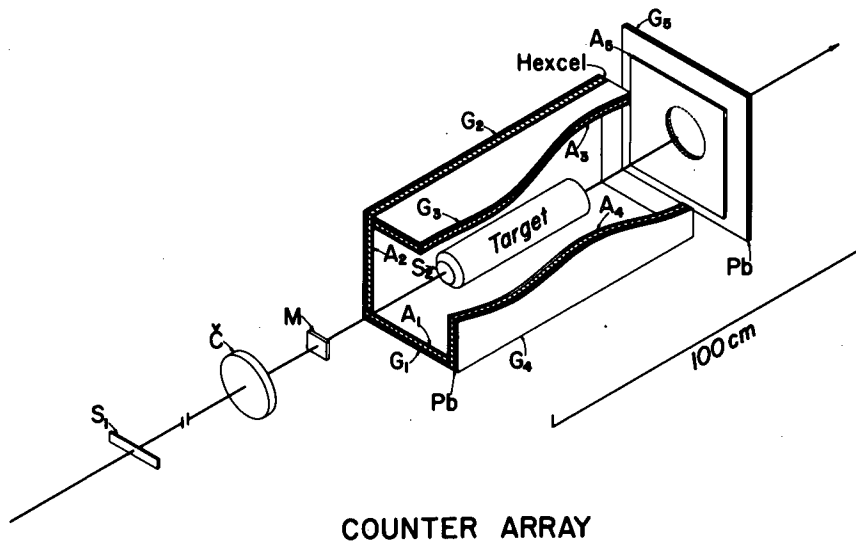


Fig. 2. Isometric projection of the apparatus used to measure the $\bar{p}p \rightarrow \bar{n}n$ cross section.

A scheme to study the backward differential cross section is sketched in Fig. 3. The target is surrounded first by a charged particle veto and then by a large cylinder of liquid scintillator. Very slow \bar{n} ($.01 < \beta < .15$) emerging from the target have a large absorption cross section and therefore a high probability of interaction in the cylinder; the arrival time measures the cm production angle. Since the ratio of the forward to backward differential cross section is about 20, there are also about 20 times the number of neutrons with the same time of flight. However, their energies are all below 10 MeV, so that any neutron interaction in the detector can be easily biased out. The forward differential cross section for \bar{n} could be measured with conventional neutron counters biased to suppress the 5% background of neutrons with the same time-of-flight.

With this it would be possible to measure carefully the energy dependence of the total and differential cross sections for $pp \rightarrow \bar{n}n$ in the forward and backward directions, with emphasis on the region of the S meson in order to clarify the quantum numbers of this peculiar structure. In particular the one pion exchange dip observed (6) in the forward direction would be a valuable benchmark. Since its magnitude and phase are presumably known, it would act as a reference amplitude, in otherwise unknown terrain, with which to analyse resonant structure via interference effects. It could thus serve a function similar to prominent Y^* resonant amplitudes which have made Kp analyses feasible in the face of incomplete data of limited accuracy.

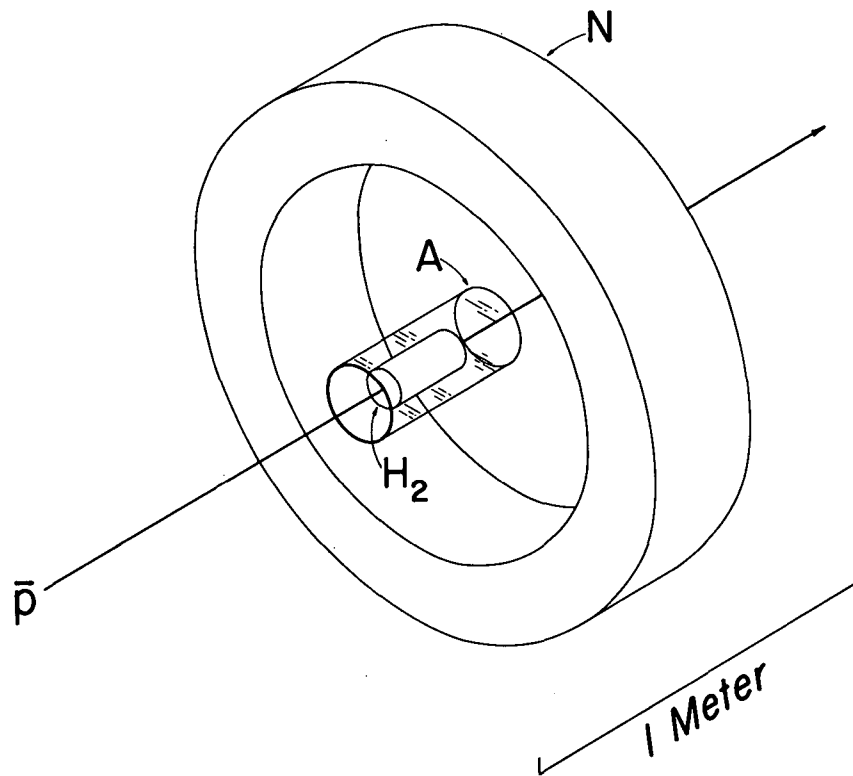


Fig. 3. Sketch of an arrangement suitable for the measurement of the backward differential cross section for pp charge-exchange scattering.

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