KN AND NN SCATTERING
BELOW 1.1 GeV/c

MASTER

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ABSTRACT

Results of statistically precise measurements of K^-p and $\bar{p}p$ scattering cross sections, obtained in the Low Energy Separated Beam of the Brookhaven National Laboratory Alternating Gradient Synchrotron, are presented and briefly discussed. No evidence for new resonances is found in K^-p backward elastic differential cross section results. In addition, no evidence is seen for either the $S(1936)$ meson or the 2020 resonance in $\bar{p}p$ backward elastic scattering, charge exchange scattering, or in $\bar{p}p$ or $\bar{p}d$ total cross section measurements.

Since January 1978 I have been involved in a series of experiments with physicists from Lawrence Berkeley Laboratory (LBL) and Brookhaven National Laboratory (BNL) performing a series of experiments in the Low Energy Separated Beam (LESB) at the BNL Alternating Gradient Synchrotron (AGS) to study kaon nucleon scattering and antiproton proton scattering below 1.1 GeV/c. To date we have measured K^-p backward elastic scattering differential cross sections, the differential cross sections of the reaction $K^-p \rightarrow \Sigma^- \pi^+$ with the π^+ emerging at 0° , the $\bar{p}p$ backward elastic scattering differential cross sections, the total reaction cross sections for $\bar{p}p \rightarrow \bar{n}n$, and the total $\bar{p}p$ and $\bar{p}d$ cross sections, all below 1.1 GeV/c, and have analyzed all the data. Results for the K^-p backward elastic scattering and $K^-p \rightarrow \Sigma^- \pi^+$ have been written up and submitted to Physical Review D and the results of the $\bar{p}p$ backward elastic analysis have been submitted to Physical Review Letters for publication. (I have previously sent preprints of these two papers to DOE.) Results for the $\bar{p}p \rightarrow \bar{n}n$ and $\bar{p}p$ and $\bar{p}d$ have been written up and will be submitted to Physical Review Letters or Physics Letters as companion papers as soon as systematic errors have been assigned to these cross sections.

The focussing magnetic spectrometer used to obtain the K^-p backward elastic differential cross sections and the 0° differential cross sections in the reaction $K^-p \rightarrow \Sigma^- \pi^+$ was described in Appendix A in my Annual Progress Report # C00-4831-1. Final results obtained with this apparatus are shown in Figure 1 with previous partial wave analyses and in Figure 2 with a recent LBL analysis. The fit in Figure 2 was obtained without requiring any new resonances in the K^-p system, in disagreement with the resonances claimed by Carroll et al. in K^-p and K^-d total cross section measurements.¹

The same focussing magnetic spectrometer was also used to measure the $\bar{p}p$ backward elastic differential cross sections. Final results of this measurement are shown in Figure 3 where the smooth curve is a fifth degree polynomial fit to the data. No evidence is seen for the S meson or the 2020 resonance at the .1 mb/ster level although the broad smooth enhancement, indicating the passage of the second diffraction maximum through 180° as the momentum changes, is clearly shown. This result is in contrast to the expected S meson contribution to the backward elastic differential cross section of at least .5 mb/ster based on the measured value of the contribution of this resonance to the elastic cross section of $7 \pm 1.4 \text{ mb}^2$ and assuming the absence of large constructive or destructive background interference effects.

The cross sections for the reaction $\bar{p}p \rightarrow \bar{n}n$ were measured with the apparatus shown in Figure 4. Antiprotons in the incident beam interacted in a short (8 cm) target and all charged reaction products were vetoed by the A scintillation counter box surrounding the target. Gammas produced in neutral annihilations from π^0 decays were vetoed with good efficiency in the G shower counters placed upstream of the target center. The only reaction which was normally not vetoed by this arrangement was the charge exchange reaction $\bar{p}p \rightarrow \bar{n}n$. Because of the small amount of material traversed by the $\bar{n}$'s and n 's, corrections for self vetoes due to nuclear interactions in this reaction were small. Overall, the total correction factor applied to the raw data was less than 1.1 in the regions of the S meson and 2020 resonance.

Final data is shown in Figure 5 along with data measured in a previous experiment with considerably poorer resolution and larger nuclear interaction corrections.³ Systematic errors in overall normalization were estimated at 5 - 10% for the open circles and 3 - 5% for the closed circles

due to uncertainties in correction factor calculations but point to point uncertainties are the order of 1%. Within these estimated normalization errors, both sets of data agree and again no evidence is seen for either the S meson or the 2020 resonance with an overall RMS momentum resolution, based on range and time-of-flight measurements, of 6 MeV/c.

The total $\bar{p}p$ and $\bar{p}d$ cross sections were measured with an apparatus similar to the one used by Carroll et al.⁴ consisting of an array of coaxial circular counters of increasing diameter downstream of a short (8 cm) target filled with hydrogen or deuterium (see Figure 6). Two major advantages of our experiment over the experiment described in Ref. 4 are the very short target and relatively small amount of material in the counter array which could cause problems in obtaining correct extrapolated cross sections. Total cross sections were calculated by extrapolation using the transmission counter method described in detail by Cool et al.⁵

Results of these experiments are shown in Figures 7 and 8. No evidence is seen for either the S meson or the 2020 resonance in either reaction. Work is currently underway to estimate the systematic uncertainties in these total cross section experiments but they appear to be 1 - 2% overall with a point to point uncertainty of about 1%. The experimental momentum resolution is identical to that obtained in the $\bar{p}p \rightarrow \bar{n}n$ reaction.

FUTURE WORK

Work is currently underway to measure the asymmetry parameter α in the decay of Σ^+ to $p\gamma$. This experiment will be carried out in collaboration with experimenters from Yale and Brookhaven Lab and performed in the Low Energy Separated Beam LESB II at Brookhaven Lab. Data taking is scheduled to begin in early 1980.

REFERENCES

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XBL 798-10887

Figure 1

Figure 2

XBL 798-11014

$\bar{p}p$ Backward Elastic Scattering

Figure 3

XDL 798-11053

Figure 4

XBL 793-8876

$\bar{P}P \rightarrow \bar{N}N$

Figure 5

Figure 6

Figure 7

Figure 8