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Measurement of the Analyzing Power in π^-p Charge Exchange at Intermediate Energies

B.M.K. Nefkens, S. Adrian, A. Eichon, J. Engelage, G. Kim, Y. Ohashi, J. Arends†, D. Sober†, W. Briscoe††, C. Seftor††. M. Taragin††, S. Graessle* and M. Sadler*

Department of Physics, UCLA Los Angeles, CA 90024
†Department of Physics, Catholic University of America, Washington, D.C. 20064
††Department of Physics, George Washington University, Washington, D.C. 20052
*Department of Physics, Abilene Christian University, Abilene, Texas 79699

The interest in pion-nucleon interactions resurged recently as a result of interesting theoretical developments.

a) Detailed quark models calculation of the baryon resonance properties are now available such as the ones obtained from the Karl-Isgur-Koniuk model.[1] Various quark models and the underlying assumptions about the quark-quark interaction and quark confinement can be investigated by testing the predicted values of the mass, width, and decay rates of the various resonances. As the πN resonances are experimentally the most readily accessible ones they form the core of any quantitative investigation.

b) A specific non linear sigma model originally discussed by Skyrme[2] has recently been expanded to describe nucleons and πN resonances. It is considered by many as an extension of QCD to the low energy domain. The Skyrmion model has led to a novel relation[3] between isospin 1/2 and 3/2 resonances with identical spin and parity and to explicit predictions[4] of the shape of the Argand diagram of the various πN partial waves.

c) Investigations of QCD at intermediate energies have led to the proposed existence of two new types of hadronic matter, namely gluonium, a color singlet digluon state and hybrid matter consisting of quarks and gluonium.[5]

d) The masses of the up and down quark appear to be slightly different, $\Delta m \sim 3$ MeV.[6] This allows for detailed model calculations of the resulting small isospin and charge symmetry breaking.

e) The Roper resonance or $P_{11}(1440)$ πN state has emerged as a major source of controversy among theorists. There are at least three widely different points of view: i) the $P_{11}(1440)$ is not a real resonance rather a manifestation of the opening of the $\pi\Delta$ channel; this possibility has been suggested by Blankleider and Walker;[7] ii) it is an ordinary three quark state that is rather broad and has a substantial inelasticity,[8,9] iii) the Roper resonance is actually a double resonance as manifested by the double poles in the complex plane, this idea has been advanced recently by the VPI group.[10]

The properties of all known πN resonances, their mass, width, inelasticities, and decay amplitudes are all obtained exclusively from partial wave analyses, PWA's. There are currently three detailed PWA's available, namely by Karlsruhe-Helsinki, K-H,[8] Carnegie-Mellon University - Lawrence Berkeley Laboratory, CMU-LBL[9] and the Virginia Polytechnic Institute and State University, VPI.[10] They differ in the data base employed and in their dependence on theoretical constraints. The last ones are necessary to fill the voids of incomplete data sets.

The UCLA Particle Physics Group in collaboration with the George Washington University, Abilene Christian University, the Catholic University of America, and LAMPF is in the process of obtaining complete data sets consisting of $d\sigma/d\Omega$, A_N, and A/R measurements at several energies covering the tail of the Δ and the Roper resonances, accessible at the LAMPF P^3 channel.[11-13]

An example of the preliminary results obtained for the analyzing power A_N in π^-p charge exchange at $p_\pi = 625$ MeV/c is shown in Fig. 1. The data was obtained using counter techniques and a transversely polarized proton target held in a 2.5 T field. Data sets at other incident energies are being analyzed and will be presented at the meeting. The results will be compared with the detailed predictions by the major PWA's[8,9,19] and the inferences for the above mentioned theoretical models will be discussed.

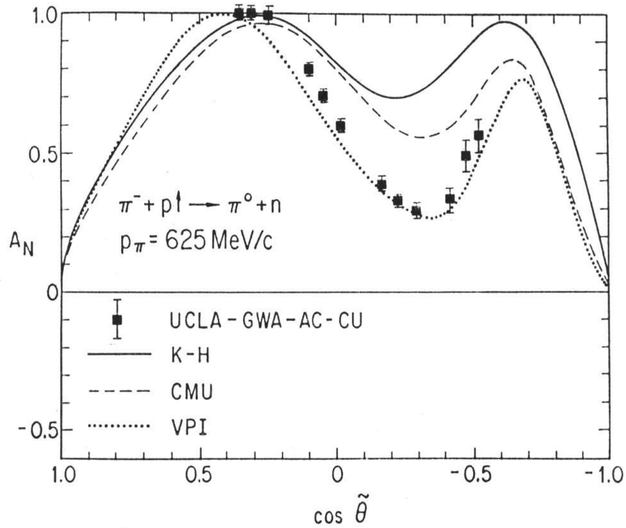

Fig. 1. Preliminary results of our experiment on the analyzing power, A_N, in $\pi^- + p\uparrow \rightarrow \pi^0 + n$ at $p_\pi = 625$ MeV/c. The three curves are the predictions of partial wave analyses by K-H,[8] CMU-LBL,[9] and VPI.[10]

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