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MASTER

PROGRESS ON RIPPLE

During most of the period of this report the RIPPLE system has been in daily use measuring films from our 11 BeV/c $\pi^+ d$ exposure obtained in the SLAC 82" bubble chamber. This effort, amounting to approximately one-half shift per day, has resulted in the measurement of several thousand events of at least three distinct experimental types. Although most of these measurements have not been useful for physics because of poor quality, this routine use has aided in the detection and correction of a wide variety of minor problems in both the hardware and software.

The most significant of these corrections involved a hardware modification which reduced the average measurement error from approximately seven microns to four microns. Many improvements of the system software have resulted in faster and more reliable measurement of tracks and fiducials. It was also determined that the fraction of events successfully measured could be substantially increased by a preliminary selection of scanned events to insure that they occurred in a region of high film quality.

Since mid-May the system has been in routine use approximately one full shift per day and has been able to measure 80 per cent of the events attempted.

A recurring problem during the past year has been the lack of core memory in the computer. This lack has resulted in many software compromises which have in turn limited the system operation. Since the main goal has been to get some measurements of physics quality, most of these compromises have been resolved at the expense of system speed and in favor of reliability. The installation of the 16K words of additional core memory funded by the recently approved supplementary grant from the NSF developmental program will permit several significant software improvements.

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Work in this area is already underway.

PROGRESS ON THE π^+d EXPERIMENT

This spring one of W. D. Walker's students from Wisconsin completed his thesis work mainly here at Duke. The subject of the thesis was "Strange Particle Production in π^+d Collisions at 7 GeV/c." The results of this experiment are contained in Dr. Lynch's Ph. D. thesis, which was prepared for the faculty of the University of Wisconsin. Last year one of our publications involved the production of K^*'s in association with Λ^o. That is the reaction $\pi^- - p \rightarrow K + \pi + \Lambda^o$. The remarkable thing about these results was that there was an apparent violation of isotopic spins if one looked at the deca[illegible] $K^*(890)$. The result was that we found much more $K^{*o} \rightarrow K^+ + \pi^-$ than we found $K^* \rightarrow K^o + \pi^o$. In Lynch's thesis we were able to once again examine this reaction but using the reaction $\pi^+ + n \rightarrow K + \pi + \Lambda^o$. This reaction which is the charged symmetric reaction to the π^-p reaction usually yields the same topology for either $K^+\pi^o\Lambda^o$ or $K^o\pi^+\Lambda^o$. This means that scanning and other experimental biases should be nearly the same regardless of the products in the final states. The result of this experiment shows a similar but a much smaller effect than which was previously observed. We find a ratio of K^{*+} decay of $K^o + \pi^+/K^+ + \pi^o$ to be about three to one as compared to our previously obtained value of 4 or 5 to 1. Isotopic spin considerations would predict the ratio should be two to one. The difficulty with the previous experiment apparently had to do with the fact that there were large scanning biases involved which tended to discriminate against the reaction $\pi^-p \rightarrow K^o\pi^o\Lambda^o$. In this final state it is necessary to observe the K^o and the Λ^o in order to reconstruct the event. Apparently there was just a loss in scanning of either the Λ or the K^o which tended to be rather fast. We also have a considerable amount of data involving $K\pi\pi + \Lambda^o$ in the final state. We are in the processing or trying to understand these reactions as well as the $K\pi\Lambda$ final state. This work is continuing with Dr. Walker and

Mr. S. Dhar at Duke.

The last reactions that we have extensive data on concerns reactions of the sort $\pi + N \rightarrow K + \bar{K} + \text{Nucleon}$ or $\pi + N \rightarrow K + \bar{K} + \pi + \text{Nucleon}$. The thesis of Dr. Lynch furnishes us a nice sample of reaction $\pi^+ n \rightarrow K_1^0 + K_1^0 + p$ or $K^+ + K^0 + \text{neutrons}$ or $K_1^0 + K_2^0 + p$. We've combined the data from Lynch's thesis with those obtained by Dr. R. Diamond of the University of Wisconsin, in which he studied $\pi^+ n$ yields $K^+ + K^- + \text{proton}$. The study of $K\bar{K}$ pairs is very interesting in that these systems show at least some of the resonance structure that one finds in the $\pi\pi$ system. It is complicated in that the G parity of the $K\bar{K}$ system is not definite as it is in the case of a $\pi\pi$ system. One of our most interesting results of the last year was published in a Physical Review Letter which appeared last November. This letter contained the essential results from the thesis of Dr. J. T. Carroll who is now at SLAC. The interesting result had to do with the fact that if one looks at the $\pi\pi$ system in the region of the f^0 (1.2 to 1.3 GeV/c^2 In the mass of dipion), then it appears that the S-wave and the D-wave amplitudes must remain practically in phase with each other. There was also evidence presented having to do with the $K\bar{K}$ system. This shows also that there was a peak in the $K\bar{K}$ mass spectrum in the region of the f^0 and if one looked at the angular distribution of decay of the $K\bar{K}$ system, this shows a state that seems to be dominated by the S-wave rather than the D-wave. This too would indicate the presence of an S-wave system of even G parity in the region of the f^0 meson. We have made a compilation of data on $(K\bar{K})^0$. We further conclude that indeed there is a strong S-wave present in the $K\bar{K}$ system in the 1.2 - 1.3 GeV/c^2 mass range.

Last, we have been looking at the $\pi K\bar{K}$ system as well. If one looks at the $K\bar{K}$ mass spectrum from this system, one also sees a strong peak in the region of the f^0 or the A_2. Undoubtedly there is a mixture of A_2 and possibly the S-wave $K\bar{K}$ system in this mass range. The $\pi K\bar{K}$ system is an interesting one to observe in that at least some of the time, it seems to come about as a result of diffractive dissociation of the π meson. This is the first system involving the diffraction dissociation of π which contains

K's as well as the π meson. We find that the $\pi K\bar{K}$ system has several strong components. One is a strong K $\bar{K}$ or $K\bar{K}$ final state, another important amplitude has to do with $\pi + K\bar{K}$ where the $K\bar{K}$ is a resonance. It would seem from these data that the π diffractively dissociates into a $K\bar{K}$ system plus an S-wave π or a P-wave π to yield a 0^- or 1^+ final state. We have in addition to the 7 GeV/c π^+d data, data obtained from the Duke SLAC exposure involving 11 BeV/c $\pi + d$ interactions. It was unfortunate that the SLAC run was not terribly successful so far as picture quality is concerned. The low picture quality has caused difficulty so far as measurements on RIPPLE are concerned and also has caused difficulty in actually scanning the pictures. We have obtained however a few thousand events involving a Λ or K^o in the final state. We are studying these processes involving K^o and Λ^o in an inclusive fashion. We have a considerable amount of data of this type from the 7 GeV/c work done by Lynch. In comparison of these two pieces of information should be rather interesting.

π-NEON INTERACTIONS

We have received approval of a 200,000 picture run in the 82" bubble chamber at SLAC. In a test run the chamber was filled with a neon hydrogen mixture. The mole percentage of neon was about 25 per cent. The main thrust of this experiment will be to look at the production of high energy resonance states in the complex nucleus. We will also hopefully be able to do additional work on coherent interactions on the neon as well as incoherent reaction. Further there is the possibility of looking at hydrogen interaction involving two or more π^o. The radiation length in the chamber under these conditions is about one to 1.25 meters which means that one has a very sizeable probability of materializing gamma-rays produced in the collision.

WORK AT N. A. L.

As mentioned in last year's proposal, we received approval for a small run at NAL using the 30" MURA-NAL bubble chamber. Last summer W. D. Walker spent two months at NAL working on components for the beam to transport particles to the 30" bubble chamber. Duke contracted to oversee the construction of a magnet to kick particles out of the bubble chamber when enough particles have traversed the bubble chamber. The magnet itself was constructed at the Physical Sciences Laboratory at the University of Wisconsin and Duke. The concept and specifications of the magnet were developed by W. D. Walker as a result of his stay at the National Accelerator Laboratory. Construction of the magnet was initiated in August 1971, and the magnet was completed in February 1972. It was actually installed at NAL in late March 1972. This device has not yet been used at NAL because of difficulties with the spill time of the particle beam. At the time of the design of the kicker it was not known under what sort of conditions the accelerator at NAL would be operating and in particular the mechanism for spilling the beams out of the machine had not yet been decided. We hope that the spill time for the machine will be stabilized in a region in which the kicker will be of use. In the meantime, we have devised a backup kicking magnet that will hold the beam out of the bubble chamber for a longer period of time.

INSTRUMENT DEVELOPMENT AT DUKE

Since the 1968 NAL summer study program which took place at Aspen we have been convinced of the necessity of using a gas target in the study of high energy collisions in the NAL energy range. The reason for this is fairly simple, namely, that as the bombarding particle energy is increased the minimum momentum that is transferred to the target decreases inversely at the bombarding momentum. Thus for a 100 BeV/c π meson to be transformed to a 1 BeV object requires a minimum of 5 MeV/c momentum transfer to the target. It is of course essentially impossible to measure such a small momentum transfer in a bubble chamber. Consequently we have been searching for a way to detect low momentum recoil which must occur in a gas target. The number of techniques that are available for doing this is quite limited. One of the techniques might be the utilization of the Wilson cloud chamber, another would be the use of a streamer chamber, and we will describe in detail a third possibility shortly. We actually set out to build a proto-type cloud chamber utilizing newer techniques so far as the illumination optics and the expansion mechanism. We actually succeeded in operating a small cloud chamber with modest success. By using good illumination optics, we had hoped to produce or to be able to see droplets before they had grown to a very large size and in this way hopefully to cut down the cycle time required in the cloud chamber. It turned out that one must still wait a relatively long time for the droplets to grow to the extent that they are visible in your optical system. As a result of this essentially fundamental difficulty we could never produce tracks to the cycle time of less than about 10 to 15 seconds. This is considerably too long a cycle time to be useful with an accelerator.

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