XVI International Conference on High Energy Physics Chicago – Batavia

Parallel Sessions: Strong interactions

Proceedings of the XVI International Conference on High Energy Physics

Parallel Sessions: Strong Interactions

Volume 1

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Proceedings published in four volumes by
National Accelerator Laboratory
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Volume 1 Parallel Sessions:
Strong Interactions
Volume 2 Parallel Sessions:
Mostly Currents and Weak Interactions
Volume 3 Plenary Sessions:
Strong Interactions
Volume 4 Plenary Sessions:
Mostly Currents and Weak Interactions

PREFACE

In preparing the written proceedings of the XVI International Conference on High Energy Physics, we have been guided less by the form of the proceedings of the last few conferences than by the somewhat new procedures adopted for this conference. The format of parallel sessions was not new, but the appointment of an autonomous organizer for each session and the introduction of the ten-day preconference workshop meant that each parallel session became an important conference in its own right, with material worthy of publication, at least in summary form. This was especially true because the invited speakers at the plenary sessions were not required to be faithful reporters of the parallel sessions.

Since the mode of organization of each session was left to the organizer, it seemed appropriate that the format and organization of the written report of the proceedings be decided by him as well. Some chose to write their own summaries, others to rely on "mini-rapporteurs," still others to include all the papers delivered, in more or less complete form. In spite of the resultant diversity in completeness and detail, the volumes on the parallel sessions provide a useful summary of the otherwise indigestible bulk of the contributed papers, 990 in all.

The plenary sessions are in part summaries of the parallel sessions and in part independent reviews and analyses. There has been close cooperation between the plenary-session speakers and the parallel-session organizers, with a view to eliminating excessive duplication in the proceedings of material first presented in parallel sessions, then summarized by a speaker at a plenary session. Some redundancy has occurred, nevertheless, because the aim of the editors has been primarily to get the proceedings into print in the shortest possible time.

The actual material of the proceedings has been divided among the volumes according to parallel (Vols. 1 and 2) and plenary (Vols. 3 and 4) sessions, and according to subject matter. Volumes 1 and 3 cover strong interactions, Volumes 2 and 4 mostly currents and weak interactions, and a number of other topics as well. In the first two volumes the contributed papers are listed at the end of each volume, sorted according to subject. Every contributed paper is listed at least once; multiple listings occur if the paper was relevant to more than one session. A small number of papers were assigned arbitrarily; the editors hope to be forgiven these few square pegs in round holes. In Volumes 3 and 4, an invited paper is usually followed by an abbreviated version of the discussion which occurred after its presentation. We and the speakers have tried to be ruthless here. The aim was to include only those parts of the discussion that manifestly added to the physics content of the session.

In the preparation of the proceedings, the work of the scientific secretaries deserves explicit acknowledgment. They assisted in the arrangements and preparations for the parallel sessions, in the reading and classification of contributed papers, in the making of data summaries and slides, in the recording of discussions at conference sessions, and finally in the preparation of the papers for publication after the conference. This frequently was a considerable effort, and much credit is due those secretaries who carried so large a fraction of the burden. We would like to single out for special notice the outstanding contributions made by M. Atac, S. D. Ellis, E. A. Paschos, K. P. Pretzl, A. I. Sanda, J. J. Whitmore, and A. B. Wicklund.

Donald H. Miller assisted most willingly in the task of scientific editing. The preparation of copy for the printer, including the typing of many manuscripts, was done with dispatch and good cheer by the NAL Publications Office under the supervision of Rene Donaldson. The cover, as well as hundreds of line drawings and graphs, were prepared in exemplary fashion by Angela Gonzales.

J. D. Jackson

A. Roberts

POSTSCRIPT

In another departure from custom, we have preserved a record of part of the conference in an entirely different medium. In order to open the conference to more than the limited number of physicists who could be accommodated as participants, the decision was made rather early in the arrangements that the plenary sessions, at least, would be broadcast over closed-circuit television to a group of television receivers in the Village Barn at NAL. This arrangement allowed many more physicists to watch the plenary sessions. Since this required the existence of a complete television link, the additional effort required to make a video-tape recording of the plenary sessions was not great, and this was done.

A similar recording (or broadcasting) of all four simultaneous sessions at the University of Chicago was not practical, but with the cooperation of the audio-visual center of the University of Illinois, Chicago Circle Campus (who contributed the very considerable technical equipment and staff required), one of the four lecture rooms used was equipped for video-tape recording. Consequently a library of video tapes exists, from which copies may be obtained, of the parallel sessions on Currents and High-Energy Interactions, and of all the plenary sessions. Inquiries concerning these may be directed to Arthur Roberts, NAL.

FOREWORD

The XVI International Conference on High Energy Physics was held in the area of Chicago, Illinois, USA. Hosts to the conference were the University of Chicago and the National Accelerator Laboratory (operated by Universities Research Association). The first half of the conference, consisting of 22 parallel sessions, was located on the Campus of the University of Chicago on Wednesday, Thursday, and Friday, September 6, 7, and 8, 1972. The 15 plenary sessions of the conference were held at the National Accelerator Laboratory on Monday, Tuesday, and Wednesday, September 11, 12, and 13.

The conference was sponsored and supported in part by the International Union of Pure and Applied Physics (IUPAP). The major financial support was provided by the United States Atomic Energy Commission and the National Science Foundation. Additional support was given to the conference by the Illinois Commission on Atomic Energy, Universities Research Association, and the University of Chicago.

In establishing a format for the conference, we benefitted from the advice of two committees, a National Advisory Committee which met with us on three different occasions, and an International Advisory Committee, composed of the members of the IUPAP Commission on Particles and Fields. We consulted with members of that committee by correspondence only.

At the suggestion of our advisory committees, in order to avoid long series of contributed papers each of short duration, we organized the parallel sessions into a series of mini-topical conferences, the organizer of each parallel session having the responsibility for selecting and assigning the material to be presented at his session. Some chose to use panel discussions, others to name "mini-rapporteurs" to summarize a particular area. Also at the recommendation of our advisory committees, we suggested that plenary speakers need not feel responsible to present summaries of every contribution made to the conference within the scope of his talk. Also at the suggestion of our advisory committees, we suggested that plenary-session speakers should feel free to give emphasis to their own interests, with consequences which should be evident from the reports appearing in these proceedings.

The detailed choices of program, organizers, and speakers were made with the advice of the Scientific Program Implementation Committee. The organizers and speakers were asked to participate in a workshop during the ten days prior to the conference. This gave them an opportunity to examine and discuss the contributions that had been received on time, to adjust the schedules of parallel sessions in the light of these contributions, and to prepare materials for presentation.

It is our impression that this and the other changes made in conference format had, on the whole, the salubrious effect on the character of the conference anticipated by our advisory committees, and we recommend them to the attention of the organizers of future conferences of comparable scope.

The decision to hold the conference at two separate locations posed special problems of logistics, making for administrative demands even more severe than usual. Mrs. Helen Peterson, who served as conference administrator, deserves great credit for successfully planning,

organizing, and arranging the operations of the conference with devoted attention to detail and a remarkably cheerful demeanor. It was also very helpful to us that CERN loaned us the services of Miss E. W. D. Steel to help with the planning and execution of this conference. All veterans of the International High Energy Physics Conference know how much Miss Steel contributes to their success through her untiring efforts, her unique experience, her tact, and her long-standing personal relationships. Our thanks are also due to Mrs. Dolores Gohus who served as coordinator of the arrangements for all activities, both technical and social, that took place on the University of Chicago campus.

The success of the ten-day, preconference workshop was due in large part to Mrs. Helena M. Heldt who served as its coordinator and managed the distribution of the 990 contributed papers both for the workshop and for the conference itself. She administered the receipt, cataloguing, and duplication of all papers that were submitted to the conference.

The workshop could not have been successful without the able help of Mrs. Rene Donaldson and her staff who managed the technical editing, typing, and the preparation of slides.

For help in all phases of the technical arrangements, from the program planning to the preparation of these proceedings and including arrangements for audio and video recording of sessions, thanks are due to Arthur Roberts who served throughout as assistant to the organizers. The initial identification and assignment to session organizers of the many papers was delegated to Carl Albright whose unremitting efforts aided the session organizers greatly.

We wish particularly to acknowledge the invaluable contributions made after the conference by J. D. Jackson. He took over many of the essential tasks related to the production of these proceedings.

Finally, but most important of all, were the contributions made by the physicists, both those who organized the parallel sessions and those who served as plenary-session speakers. They all worked hard for long hours, many for a period of several weeks beginning with the pre-conference workshop, through to the end of the conference and beyond. On the next page are listed the members of the three major committees which worked with us in organizing the conference. They gave valuable time and invaluable advice.

Edwin L. Goldwasser

Robert G. Sachs

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Resonances I: Partial Wave Analysis of Resonances Observed in Production Processes

Organizer: U. E. Kruse
Scientific Secretaries: F. Halzen
C. E. W. Ward
A. B. Wicklund

RESONANCES I - PARTIAL WAVE ANALYSIS OF RESONANCES OBSERVED IN PRODUCTION PROCESSES

Topic	Speaker
1. $K\pi$ Phase Shifts	H. Bingham (California, Berkeley)
2. Partial Wave Analysis of the A_1, A_2, and A_3	G. Ascoli (Illinois, Urbana)
3. I = 2 S- and D-Wave $\pi\pi$ Phase Shifts in the Low Energy Region	J. Poirier (Notre Dame)
4. Experimental Results on $\pi\pi$ Scattering	R. K. Carnegie (SLAC)
5. A Multichannel Model for the Production of the A_1	J. Wright (Illinois, Urbana)
6. Theoretical Aspects of $\pi\pi$ Scattering	R. Warnock (IIT)

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High-Energy Collisions I and II

High-Energy Collisions III - Production Processes at High Energies, Experimental

$K\pi$ PHASE SHIFTS

Presented by H. Bingham
University of California
Berkeley, California

The $K\pi$ elastic scattering has been analyzed using an energy-independent phase-shift analysis for the reaction $K^+p \to K^+\pi^-\Delta^{++}$ at 12 GeV/c for $K\pi$ masses between 800 and 1000 MeV. The results will appear in the thesis of Maxine Matison.

In the analysis, a Breit-Wigner formula is used to describe the $K^*(890)$ P wave. The mass and width, $M = 896 \pm 1.5$ MeV and $\Gamma = 47 \pm 2.8$ MeV, are determined from our data using the extrapolated p-wave cross section. For the I = 3/2 s-wave, we use the small, negative phase shift that has been found in previous experiments. Using the extrapolated normalized moments $\langle Y_1^0 \rangle$ and $\langle Y_2^0 \rangle$, we find a slowly-varying "down" solution for δ_1^0, the J = 1/2, s-wave phase shift. This solution gives an approximate straight line for δ_1^0 going from 20° at $M(K\pi)$ = 800 MeV to 60° at $M(K\pi)$ = 1000 MeV (see Fig. 1).

At some $K\pi$ masses we find a second solution with an acceptable χ^2. This second "up" solution, when connected to the lower branch of the down solution and the upper branch of the down solution + 180°, could imply the existence of a narrow resonance, although the down solution is preferred. If we use the unextrapolated $|t| < 0.1$ moments in the phase-shift analysis, we find a similar picture, except that the up solution looks more continuous than in the extrapolated data, so that neither solution is favored. However, the unextrapolated data have the disadvantage of not being unitary at some $K\pi$ masses (so that both the up and down solutions have bad χ^2).

We investigate the possibility of a narrow resonance and find:

1. If the down solution is the true solution (no narrow resonance) then, because of a mathematical ambiguity when using Y_1^0 and Y_2^0 only, we must always find an up "solution" near the $K^*(890)$, i.e. the down solution together with the rapidly changing p-wave of the $K^*(890)$ create an up "solution." An accurate measurement of the total cross section will resolve this ambiguity except near the $K^*(890)$ where the ambiguity is unresolvable.

2. If the up solution is the true solution (corresponding to a narrow resonance for the s-wave), then this up solution together with the $K^*(890)$ p-wave will also create a down "solution." However the resulting down "solution" will in general not follow a smooth behavior unless the up solution occurs by coincidence within ±20 MeV of 870 MeV.

3. A small change in the moments near $M(K\pi)$ = 860 MeV can produce large changes in the phase shifts, pushing the down solutions to higher values and thus creating a discontinuity in the down solution and the appearance of continuity in an up solution.

We see that near the $K^*(890)$, circumstances can combine to give the appearance of a narrow s-wave resonance whether or not one is there. In view of the above three points, and of the fact that we see no evidence for such a resonance in any measured quantity, we think that the existence of such a resonance is unlikely.

When we use the extrapolated total cross section to further constrain the solutions we are left with only three points of the up solution which have acceptable χ^2's. These are just at $M(K\pi)$ = 890, 900, and 910 MeV corresponding to the unresolvable points mentioned in (1). The results are shown in Fig. 1. In conclusion, we find that if we believe in the extrapolation of Y_1^0, Y_2^0, and the total cross section, we can rule out a narrow resonance up solution.

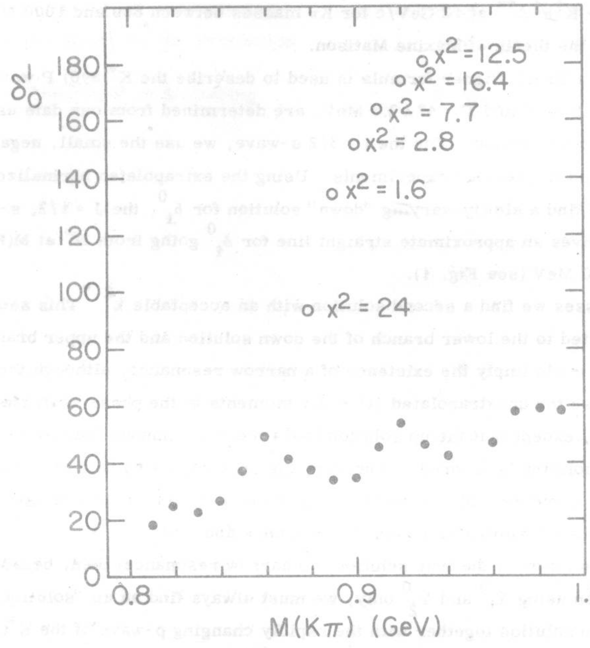

Fig. 1. Phase shift δ_0^1 (isotopic spin 1/2, s wave) solutions in the $K^*(890)$ region, obtained using the extrapolated values for total cross section, $<Y_{10}>$ and $<Y_{20}>$. For the down solution (dots) the average χ^2 was found to be 2 in agreement with 2 degrees of freedom. For the up "solution" (circles) the χ^2 values are given for the points near 890 MeV.

Partial Wave Analysis of the A_1, A_2, and A_3

Presented by G. Ascoli, University of Illinois, Urbana, Illinois

The 3π system produced in the reaction $\pi^- p \rightarrow p\pi^-\pi^-\pi^+$ has been studied in the range 5-40 GeV/c using Bubble Chamber data from 5 to 25 GeV/c (World $\pi^- p$ collaboration)[1] and spectrometer data at 25 and 40 GeV/c (CIBS collaboration).[2] These data are consistent; they determine the spin parities and dominant decay modes of the A_1, A_2, and A_3 and give us information on their production amplitudes.

In the region of the A_1 (~1.1 GeV) the state with $J^P = 1^+$ and decaying by S wave to $\rho\pi$ is the only state showing a clear enhancement; in the A_2 region (~1.3 GeV) only the state with $J^P = 2^+$ decaying by D wave to $\rho\pi$ shows an enhancement; and in the A_3 region (~1.65 GeV) only the state with $J^P = 2^-$ decaying by D wave to $f\pi$ shows an enhancement. The phase of the A_2 production amplitude varies with the mass of the 3π system as we would expect for a resonance, however the A_1 and A_3 production amplitudes (with the A_1 and A_3 states defined as above) do not show any variation in phase with respect to the production amplitudes of other states. The phase of the A_1 and A_3 amplitudes with respect to other amplitudes are shown in Figs. 1 and 2.

The dependence on s of the A_1, A_2, and A_3 production cross sections are consistent with power law behavior $\sigma \propto p_{lab}^{-n}$. The values of n found in the bubble chamber data are A_1:n_1~.5±.2; A_2:n_2=.57±.09; A_3:n_3=.8±.3. For the A_2 this power law applies for the natural parity exchange contribution which dominates the production above 11 GeV/c. Below 11 GeV/c there are further contributions from unnatural parity exchange which fall off as $p_{inc}^{-1.8}$. The results for the A_2 are shown in Fig. 3. The s and t dependence of the natural parity exchange part of the A_2 cross section has been analyzed in terms of an effective Regge trajectory. A Regge trajectory of slope 1 gives a good fit with an intercept $\alpha_{eff}(t=0) = .84\pm.05$.