МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ ПО ФИЗИКЕ ВЫСОКИХ ЭНЕРГИЙ 1964

ДУБНА, СССР
АВГУСТ 1964

Уважаемый товарищ!

Ввиду того, что число аннотаций докладов, представленных на эту конференцию, очень велико, они все не помещаются в переплете.

Устройство переплета позволяет перемещать и заменять материалы, содержащиеся в нем. Для того, чтобы отпереть замок переплета, необходимо нажать на маленький рычажок, находящийся в нижней части корешка.

Пожалуйста, определите сами: какие секции Вас непосредственно интересуют и вставьте их в переплет. Остальные материалы Вы можете хранить в пакете.

Dear Sir,

The amount of abstracts of the papers submitted to this Conference is too large to be inserted into this binding.

The mechanism of the binding permits to move and replace the materials contained. In order to unlock the binding one should press the little lever which is placed in the lower part of the back.

It is for you to decide: which sections you take interest in. Insert them into the binding yourself. The remaining materials can be kept in the envelope.

СОДЕРЖАНИЕ
CONTENTS

1 Бюллетень
Bulletin

2 Список участников
List of Participants

3 Программа
Programme

4 Аннотации
Abstracts

1

1. Бюллетень
Bulletin

Август 1964 год

Б Ю Л Л Е Т Е Н Ь

На параллельных секционных заседаниях предполагается заслушать краткие сообщения по 7 мин. (плюс 3 мин. для обсуждения) и приглашенные доклады по 15 мин. (плюс 5 мин. для обсуждения).

Время для зачтения раппортерского доклада на пленарном секционном заседании 45 мин. (плюс 30 мин. для обсуждения).

В связи с большим количеством поступивших докладов от участников конференции Оргкомитетом принято решение объединить некоторые из них.

Все доклады на параллельных и секционных заседаниях, а также дискуссии будут обеспечены синхронным переводом и магнитофонной записью.

Тексты сообщений, объединенных и приглашенных докладов, а также раппортерских докладов должны быть сданы в секретариат конференции за два дня до выступления для подготовки их к синхронному переводу. После выступления, не позднее чем через сутки, проверенные и утвержденные авторами тексты докладов и дискуссии по ним сдаются научным секретарям для передачи в редакционную комиссию, в виде, готовом к изданию в трудах конференции.

Текст сообщения вместе с чертежами и рисунками не должен превышать 5 страниц машинописного текста, текст приглашенного доклада 10 страниц.

В противном случае Оргкомитет не берет на себя ответственности за опубликование доклада в трудах конференции.

Распорядок дня конференции

На конференции будут иметь место пленарные и параллельные секционные заседания, которые будут проходить в городском Доме культуры и конференц-зале Лаборатории теоретической физики (см. план).

Начало утренних заседаний - 9.30 утра.

Размещение

Участники конференции будут размещены в гостинице "Дубна", ее филиале и в других гостиницах.

По всем вопросам обращаться к дежурному администратору гостиницы "Дубна"(см.план).

Питание

Проживающие в гостинице "Дубна" участники конференции питаются в ресторане гостиницы, проживающие в других гостиницах питаются в городской столовой (см. план), а также в буфетах при городском Доме культуры и Лаборатории теоретической физики. В упомянутых буфетах в перерывах между заседаниями можно будет получить кофе, чай, бутерброды и прохладительные напитки за наличный расчет.

Во всех пунктах питания можно получить:

завтраки с 7.30 до 10.00
обеды с 13.00 до 16.00
ужины с 19.00 до 23.00

Отдых

1. 8 августа дирекция Института организует посещение лабораторий Объединенного института ядерных исследований. В этот же день будут проведены дополнительные семинары. Время и место будет сообщено в специальных объявлениях.

2. 9 августа 1964 года Оргкомитет конференции организует прием на пароходе, который совершит рейс по Московскому морю. Время поездки, место сбора и другие данные будут сообщены в пригласительных билетах.

3. В период конференции будут организованы поездки в Москву для осмотра новых районов столицы, ВДНХ, посещения музеев и т.п. Ориентировочно стоимость поездки в Москву 3 руб. Для жен участников конференции по желанию могут быть организованы самостоятельные группы. Для них же в дни конференции будет организован осмотр школ, детских садов и яслей в г. Дубне.

11 августа в 20 час. в городском Доме культуры участникам конференции будет дан эстрадный концерт силами московских артистов.

В свободное от работы время участники конференции могут посетить кинотеатры в Доме ученых , Доме культуры и его филиале (см. план).

Транспорт

Между Москвой и Дубной курсирует пригородный поезд.

РАСПИСАНИЕ ДВИЖЕНИЯ ПОЕЗДОВ НА ЛЕТНИЙ ПЕРИОД ДУБНА–МОСКВА

Из Дубны		Из Москвы	
Отправление из Дубны	Прибытие в Москву	Отправление из Москвы	Прибытие в Дубну
6-27	8-56	8-33	II-0I
II-I2	I3-34	I5-56	I8-29
I4-44 (по субботам)		I8-00 (суббота и воскресенье)	
I5-26	I7-48	I9-40	22-I0
I6-45 (кроме субботы)			
I8-42	2I-II		
2I-09 (суббота, воскресенье)			

Стоимость проезда до Москвы I руб. 46 коп.

Желающие могут поехать в Москву автомобильным транспортом.

Оплата проезда по такси.

Корреспонденция

Всю корреспонденцию можно будет получить в вестибюле гостиницы "Дубна" и в секретариате конференции.

Материалы конференции

Материалы конференции предполагается издать в феврале I965 года. Стоимость издания примерно I0 руб. Участники конференции платят 50% стоимости. Бланк заказа материалов можно получить в информационном центре конференции. Заполненный бланк возвращается в информационный центр с оплатой стоимости заказа.

Обмен валюты

При гостинице "Дубна" будет работать касса по обмену валюты.

Поездки в институты Советского Союза

13 августа день отъезда делегатов конференции, которые не принимают участия в заседаниях по новым методам и идеям в области аппаратуры для физики высоких энергий.

По окончании конференции будут организованы поездки по некоторым лабораториям Советского Союза. Группы будут укомплектованы в соответствии с ранее поданными заявками.

Точное время выезда каждой группы будет объявлено особо.

Информационный центр конференции помещается в Доме культуры.

По всем возникающим вопросам участники конференции могут обращаться к члену Оргкомитета конференции Сергиенко В.Н. (тел. 2-37) и к члену секретариата конференции Хангулову В.Т. (тел. 2-51).

AUGUST 1964

BULLETIN

At the Conference Parallel Sessions there will be reported 7-min. contributions with 3-min. discussions following, and 15-min. invited papers with 5-min. discussions.

At Plenary Sessions 45-min. are allocated to review reports of rapporteurs with 30-min. for discussion.

Since a number of papers presented by Conference participants is too large, the Organizing Committee has decided to combine some of them.

All reports and discussions will be tape-recorded and translated simultaneously.

The texts of contributions and invited papers as well as the reports of rapporteurs should be given to the Conference Secretariat two days before the relevant session to have them translated. Revised and signed by the authors papers ready to be published in the Proceedings should be given to the Scientific Secretaries.

The texts of contributions and invited papers should not exceed 5 and 10 pages, respectively, including drawings and figures. Otherwise, the Organizing Committee can't be responsible for publication in the Conference Proceedings.

CONFERENCE TIMETABLE

The Conference will include Plenary and Parallel Sessions which will be held at the Dubna Palace of Culture and in the Conference Hall of the Laboratory of Theoretical Physics (see the plan). Morning sessions begin at 9.30 a.m. The opening of the Conference will be held on August 5th at 9.30 a.m. at the Dubna Palace of Culture.

ACCOMODATIONS

Conference participants will be staying in the hotel "DUBNA", and others.

All questions concerning accomodation should be addressed to the hotel "DUBNA" Manager.

RESTAURANT FACILITIES

Meals will be served at the restaurant of the hotel "DUBNA" for its guests, and at the Public Dining Hall for those staying in other hotels, as well as at the canteens of the Palace of Culture and of the Laboratory of Theoretical Physics. There one can have tea, coffee, lemonades, and sandwiches, according to the price list.

Meals will be served:

breakfast - from 7.30 a.m. to 10.00 a.m.
dinner - 1.00 p.m. to 4.00 p.m.
supper - from 7.00 p.m. to 11.00 p.m.

at all the places mentioned.

REST

On Saturday, August 8th the Institute Direction will organize visits to the laboratories of the Joint Institute for Nuclear Research. On the same day some additional seminars will be held. Time and place will be specially announced.

On Sunday, August 9th the Organizing Committee will arrange a reception party during the boat trip on the Moscow Sea. Detailed information will be given in invitation cards.

During the conference some trips to Moscow will be organized to visit the Exhibition of National Economy, Moscow Museums and to go sightseeing. An approximate price of tickets is 3 roubles. Participants' wives, if they wish, can form independent groups. In addition, wives will have the possibility to visit Dubna schools, kindergartens and nurseries.

On Tuesday, August 11th a variety concert of Moscow artists will be held for Conference participants at the Palace of Culture.

During the time free of sessions participants can go to the cinemas of the Scientists' Club, the Palace of Culture and its Department (see the plan).

TRANSPORT

If you wish to go to Moscow, you may take the train Dubna-Moscow, the schedule of which is as follows:

From Dubna		From Moscow	
Departure	Arrival at Moscow	Departure	Arrival at Dubna
6.27 a.m.	8.56 a.m.	8.33 a.m.	11.01 a.m.
11.12 a.m.	1.34 p.m.	3.56 p.m.	6.29 p.m.
2.44 p.m.	Saturday	6.00 Saturday Sunday	8.39 p.m.
3.26 p.m.	5.48 p.m.	7.40 p.m.	10.10 p.m.
4.45 p.m.	except Saturday		
6.42 p.m.	9.11 p.m.		
9.09	Saturday, Sunday		

The fare is 1.46 roubles.

If desired, one may go to Moscow by car. Payment should be made according to the tariff of fares.

CORRESPONDENCE

The correspondence available for conference participants will be delivered at the hotels and at the Conference Secretariat.

CONFERENCE PROCEEDINGS

The Conference Proceedings are supposed to be issued in February 1965. An approximate price of one volume is 10 roubles. Conference participants may obtain one copy at a 50% price. One can find an Order Form for the Proceedings at the Information Bureau (only cash orders will be accepted).

CURRENCY EXCHANGE

Currency exchange will be done at the hotel "DUBNA".

POST-CONFERENCE TOURS

Thursday, August 13th will be departure day for those not participating in the Instrumentation Conference.

After the Conference visits will be arranged to some of the USSR Institutes. Groups will be composed in accordance with the requests sent in previously. An exact time of each group departure will be announced especially.

The Conference Information Bureau is at the Palace of Culture.

With all possible questions please address to

V.N.SERGIENKO, Member of the Organizing Committee (tel. 2-37) and

V.T.KHANGULOV , Member of the Conference Secretariat (tel. 2-51) .

ОРГАНИЗАЦИОННЫЙ КОМИТЕТ XII МЕЖДУНАРОДНОЙ КОНФЕРЕНЦИИ ПО ФИЗИКЕ ВЫСОКИХ ЭНЕРГИЙ В ДУБНЕ. 1964 г.

THE ORGANIZING COMMITTEE FOR THE XII INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS IN DUBNA . 1964.

Д.И.Блохинцев - председатель	D.I.Blokhintsev - Chairman
Г.С.Афонин	G.S.Afonin
А.И.Алиханов	A.I.Alikhanov
А.И.Алиханян	A.I.Alikhanyan
Н.Н.Боголюбов	N.N.Bogolubov
Г.И.Будкер	G.I.Budker
А.М.Балдин	A.M.Baldin
В.И.Векслер	V.I.Veksler
А.К.Вальтер	A.K.Valter
С.В.Вернов	S.V.Vernov
И.И.Гуревич	I.I.Gurevich
В.П.Джелепов	V.P.Dzhelepov
В.Г.Кириллов-Угрюмов	V.G.Kirillov-Ugryumov
Е.Г.Комар	E.G.Komar
А.П.Комар	A.P.Komar
А.М.Рыжов	A.M.Ryzhov
А.Н.Тавхелидзе	A.N.Tavkhelidze
А.А.Логунов	A.A.Logunov
М.А.Марков	M.A.Markov
К.Н.Мещеряков	K.N.Meshcheryakov
С.Я.Никитин	S.Ya.Nikitin
Б.М.Понтекорво	B.M.Pontecorvo
Б.С.Поздняков	B.S.Pozdnyakov
В.Н.Сергиенко	V.N.Sergienko
Н.Г.Коньков	N.G.Konkov

2. Список участников
List of Participants

2

LIST OF PARTICIPANTS

Country	Institute/Laboratory	Name
	PRETORIA,	E. van der Spuy
Austria	VIENNA, Institut für Theoretische Physik der Universität	W. Thirring
Belgium	BRUSSELS, Laboratoire des Hautes Energies	M.F. Grard
	BRUSSELS, Université Libre de Bruxelles	J. Reignier
Brazil	RIO DE JANEIRO, Centro Brazileiro de Pesquisas Fisicas	J. Tiomno S.W. MacDowell M. Schönberg
Bulgaria	SOFIA, Institute of Physics	P. Markov K. Khristov
Canada	VANCOUVER, University of British Columbia	G.M. Volkoff
Czechoslovakia	Dubna, JINR	I. Ulehla F. Lehar
	PRAGUE, Faculty of Technical and Nuclear Physics	J. Fischer
	RZHEZH, Institute of Nuclear Research	Z. Korbel F. Janouch
	PRAGUE, Institute of Physics	J. Pernegr
	BRATISLAVA University	M. Petrash
Denmark	COPENHAGEN, Institute for Theoretical Physics	L.K. Hansen Z. Koba
	COPENHAGEN, Nordita	S. Tanaka
Finland	HELSINKI, Institute of Physics	L.Simons
France	LE BOIS MARIE, Institut des Hautes Etudes Scientifiques	J. Lascoux
	ORSAY, Laboratoire Joliot-Curie	R. Nataf
	ORSAY, Laboratoire de Physique Théorique et Hautes Energies	C. Bouchiat B. d'Espagnat
	ORSAY, Laboratoire de l'Accélérateur Linéaire	P. Lehmann

Country	Institute/Laboratory	Name
France (cont'd)	ORSAY, Laboratoire de Physique Théorique et Hautes Energies	M. Levy
	ORSAY, Laboratoire de l'Accélérateur Linéaire	J. Perez y Jorba
	PARIS, Collège de France	A. Astier
	PARIS, Ecole Polytechnique	L. Jauneau A. Lagarrigue P. Fleury L. Leprince-Ringuet
	PARIS, Institut Henri Poincaré	J.P. Vigier
	SACLAY, Service de Physique Mathématique	M. Froissart M. Jacob
	SACLAY, Laboratoire de Physique Corpusculaire àHaute Energie	A. Leveque M. Neveu
	SACLAY, Laboratoire de Physique Corpusculaire à Haute Energie	G. Valladas
	SACLAY, Service de Physique Mathématique	D. Zwanziger
German Democratic Republic	BERLIN, Institut für Theoretische Physik	F. Kaschluhn W. Zöllner
	LEIPZIG, Institut für theoretische Physik	G. Heber
	ZEUTHEN, Forschungsstelle für Physik hoher Energien	K. Lanius H. Meier U. Kundt
German Federal Republic	AACHEN, Physikalisches Institut der Universität	M. Deutschmann
	BONN, Physikalisches Institut der Universität	K.H. Althoff H. Rollnik
	GENEVA, CERN	H. Faissner H. Filthuth
	HAMBURG, Institut für Theoretische Physik	W. Teis
	HAMBURG, DESY	H. Joos E. Lohrmann P. Stähelin G. Weber

Country	Institute/Laboratory	Name
German Federal Republic (cont't)	MAINZ, Institut für Kernphysik der Universität	P. Beckmann
	MUNICH, Max-Plank- Institut	H.P. Duerr K. Gottstein H.A. Kastrup N. Schmitz
Greece	ATHENS, Nuclear Research Centre "Democritus"	A. Contogouris
Hungary	DUBNA, JINR	G. Domokos E. Fenyves
	BUDAPEST, Hungarian Academy of Sciences	K. Ladany
	BUDAPEST, Institute of Theoretical Physics	G. Marx A. Somodi
India	BOMBAY, Tata Institute of Fundamental Research	S.N. Biswas M.G.K. Menon Yash Pal B.V. Sreekantan B.M. Udgaonkar
	DELHI, University of Delhi	A.N. Mitra
	MADRAS, Institute for Mathematical Studies	Alladi Ramakrishnan
Israel	REHOVOTH, the Weizmann Institute of Science	Y. Eisenberg G. Yekutieli
Italy	GENEVA, CERN	G. Bernardini
	ROME, Istituto di Fisica	R. Bizzari
	TRIESTE, Istituto di Fisica	P. Budini
	FRASCATI, Laboratori Nazionali del Sincrotrone	N. Cabibbo B. Touschek
	PADUA, Istituto di Fisica	M. Cresti N. Dallaporta
	GENOA, Istituto di Fisica	G. Diambrini

Country	Institute/Laboratory	Name
Italy (cont't)	FLORENCE, Istituto di Fisica	R. Gatto
	BOLOGNA, Istituto di Fisica	G. Glacomelli A. Quareni
	NAPLES, Istituto di Fisica	R. Querzoli
	PISA, Istituto di Fisica	R.A. Radicati G. Stoppini
	TORINO, Istituto di Fisica	G.Wataghin
Japan	TOKYO, Institute for Nuclear Study	A. Kusumegi J. Nishimura
	COPENHAGEN, Institute for Theoretical Physics	J. Koba
	HIROSHIMA University	Sh. Ogawa
	MÜNCHEN, Max-Plank Institute für Physik und Astrophysik	K. Yamazaki
Jugoslavia	ZAGREB, Rudjer Boskovic Nuclear Institute	B. Jaksic
	GENEVA, CERN	B. Maglic
Korean People's Democratic Republic	DUBNA, JINR	Kim Hi In
Mexico	MEXICO, Instituto de Fisica	M. Moshinsky
Netherlands	AMSTERDAM, Institute of Theoretical Physics	S.A. Wouthuysen
	AMSTERDAM, Zeeman Laboratorium	J.C. Kluyver
	GRONINGEN, Institute of Theoretical Physics	H.A. Tolhoek
Norway	BLINDERN, Fysisk Institutt	O. Skjeggestad
	TRONDHEIM, Fysisk Institutt	H.A. Olsen
Poland	WARSAW, Institute of Nuclear Research	E.Bartke W.Birula-Bialynicki W.Krolikowski R.Sosnowski J.Werle
	WARSAW University	J.Pniewski
	KRAKOW , Institute of Nuclear Research	J.Gierula M.Miesowicz

Country	Institute/Laboratory	Name
Rumania	BUCHAREST, Institute of Atomic Physics	S. Ciulli A. Mihul D. Neagu M. Petrashku S. Titeica
Spain	GENEVA, CERN	A. Galindo
Sweden	STOCKHOLM, Institute of Physics LUND, Institute of Physics	G. Ekspong S. von Friesen A.O.G. Källen
Switzerland	GENEVA, CERN	D. Amati R. Armenteros D. Cundy T.E.O. Ericson J. Fidecaro B. French J.M. Gaillard Y. Goldschmidt-Clermont B.P. Gregory L. Montanet D.R.O. Morrison F. Muller Ch. Peyrou P. Preiswerk J. Prentki C. Rubbia V. Soergel J.C. Sens M. Veltman V.F. Weisskopf A. Zichichi L. Van Hove A. Diddens
	GENEVA, Institut de Physique Nucleaire	E. Heer
	ZÜRICH, Physikalisches Institut der ETH	W. Beusch K. Hepp
United Kingdom	BIRMINGHAM University	D.C. Colley
	BRISTOL, H.H. Wills Physical Laboratory	D.H. Perkins
	CAMBRIDGE, Rutherford Laboratory	J. Polkinghorne
	CAMBRIDGE, Department of Applied Mathematics and Theoretical Physics	J.G. Taylor

Country	Institute/Laboratory	Name
United Kingdom (cont'd)	CHILTON, N.I.R.N.S. Rutherford High Energy Laboratory	J.J. Thresher
	GLASGOW University	I.S. Hughes
	HARWELL, Atomic Energy Research Establishment	R.J.N. Philips A.E. Taylor
	LONDON, Imperial College of Science and Technology	C. Lovelace P.T. Matthews J.A. Newth A. Salam
	LONDON, University College	C. Henderson
	LONDON, Westfield College	E.H. Bellamy
	LIVERPOOL University	P.T. Andrews
	OXFORD, Clarendon Laboratory	R.E. Peierls
	OXFORD, Nuclear Physics Laboratory	A.B. Clegg
U S A	ARGONNE National Laboratory	M. Derrick R. Hildebrand A. Roberts
	BERKELEY, University of California	R. Birge S. Glashow S. Goldhaber G.G. Kalbfleisch L. Kerth S. Mandelstam E.M. McMillan D. Miller B. Moyer R. Ross H. Stapp H. Steiner S. Weinberg A.C. Zemach
	BROOKHAVEN National Laboratory	R.L. Cool W.B. Fowler M. Goldhaber T.F. Kycia S.J. Lindenbaum R.F. Peierls D. Robinson N. Samios
	BROWN University	R. Lanou

Country	Institute/Laboratory	Name
U S A (cont'd)	CALIFORNIA Institute of Technology	F. Frautschi M. Gell-Mann A. Tollestrup F. Zachariasen R.F. Bacher
	CARNEGIE Institute of Technology	R.E. Cutkosky J. Ashkin
	CHICAGO University	H.L. Anderson Y. Nambu R. Öhme J.J. Sakurai V.L. Telegdi
	CASE Institute of Technology	F. Reines
	COLUMBIA University	G. Feinberg M. Schwartz R. Serber
	CORNEL University	H.A. Bethe P. Carruthers J. Orear A. Silverman
	HARVARD University	A.E. Brenner S.R. Coleman N.F. Ramsey J.S. Schwinger R. Wilson
	HAWAII University	V.Z. Peterson
	ILLINOIS University	E.L. Goldwasser J.D. Jackson K. Nishijima A. Wattenberg
	JOHNS HOPKINS University	T. Fulton A. Pevsner
	LOS ANGELES, University of California	D.H. Stork H.K. Ticho
	MARYLAND University	G.A. Snow G.T. Zorn
	MASSACHUSETTS Institute of Technology	M. Deutsch J.I. Friedman K.A. Johnson L.S. Osborne

Country	Institute/Laboratory	Name
U S A (cont'd)	MICHIGAN University	L.W. Jones D.I. Meyer M. Ross D. Sinclair K. Terwilliger
	NEW-YORK University	M. Ruderman B. Zumino
	NEW YORK, Rockefeller Institute	A. Pais
	NORTHWESTERN University	M.M. Block R.H. Capps R.A. Schluter
	PENNSYLVANIA University	A.K. Mann B.W. Lee
	PRINCETON University	R. Blankenbecler J. Cronin V. Fitch M.L. Goldberger S. Treiman
	ROCHESTER University	J. Tinlot G. Sudarshan E. Thorndike R.E. Marshak S. Okubo
	RUTGERS University	R. Plano
	SAN DIEGO, University of California	W.R. Frazer O. Piccioni
	STANFORD University	S. Berman S. Drell R. Hofstadter W. Panofsky J. Ballam L. Schiff
	WASHINGTON University	G. Masek
	WASHINGTON, Office of Naval Research	J.H. Fregeau
	WASHINGTON University	M. Baker
	WISCONSIN University	U. Camerini W.F. Fry R.F. Sawyer W.S. Walker C. Goebel
	YALE University	R. Adair G. Breit H. Taft

U S S R	DUBNA, Joint Institute for Nuclear Research	D.I. Blokhintsev
		V.I. Veksler
		I.V. Chuvilo
		I.N. Semenyushkin
		M.I. Podgoretsky
		A.L. Lyubimov
		K.D. Tolstov
		M.I. Soloviev
		A.A. Kuznetsov
		I.V. Moroz
		M.N. Khachaturyan
		R.A. Kopylov-Sviridov
		L.N. Strunov
		E.I. Maltsev
		I.M. Gramenitsky
		E.N. Kladnitskaya
		E.N. Tsyganov
		R.M. Lebedev
		V.A. Nikitin
		V.S. Stavinsky
		V.P. Dzhelepov
		B.M. Pontecorvo
		A.A. Tyapkin
		Yu.M. Kazarinov
		A.I. Mukhin
		L.I. Lapidus
		M.G. Mescheryakov
		G.I. Selivanov
		B.M. Golovin
		V.M. Sidorov
		Yu.A. Shcherbakov
		V.B. Flyagin
		N.I. Petrov
		L.M. Soroko
		A.F. Pisarev
		Ya.A. Smorodinsky
		V.S. Barashenkov
		V.G. Soloviev
		V.I. Ogievetsky
		P.S. Isayev
		S.S. Gershtein
		A.N. Tavkhelidze
	MOSCOW, Institute of Theoretical and Experimental Physics	A.I. Alikhanov
		V.V. Vladimirsky
		M.S. Kozodayev
		S.Ya. Nikitin
		A.G. Meshkovsky
		V.A. Lyubimov
		A.O. Vaisenberg
		I.Ya. Pomeranchuk
		L.B. Okun
		B.L. Ioffe
		K.A. Ter-Martirosyan
		I.S. Shapiro
		V.B. Berestetsky
		A.P. Rudik
		I.Yu. Kobzaryev
		L.L. Goldin
		Ya.M. Selektor

U S S R (cont'd)	MOSCOW, Institute of Theoretical and Experimental Physics (cont'd)	I.I. Levintov V.T. Smolyankin G.P. Eliseyev N.S. Meiman
	MOSCOW, The I.V. Kurchatov Institute of Atomic Energy	A.B. Migdal K.N. Mukhin I.I. Gurevich P.E. Nemirovsky P.E. Spivak
	MOSCOW, The State Atomic Energy Committee of the U S S R	V.F. Gordeyev V.D. Burlakov K.N. Meshcheryakov L.P. Panikov E.S. Bezrukov G.S. Afonin D.P. Filippov V.A. Vasilyev A.N. Kurakin O.S. Lupandin
	MOSCOW, The USSR Academy of Sciences	V.F. Kuleshov
	MOSCOW, The Lebedev Physical Institute	I.E. Tamm A.M. Baldin E.L. Feinberg V.S. Fradkin G.T. Zatsepin N.A. Cherenkov Ya.A. Markov M.I. Dayon V.A. Petukhov A.E. Chudakov S.A. Slavatinsky L.I. Mazur A.S. Monin Ya.B. Zeldovich A.I. Isakov
	MOSCOW, Institute of Nuclear Problems of the USSR Academy of Sciences	I.M. Khalatnikov I.E. Dzyaloshinsky
	MOSCOW, The V.A. Steklov Institute of Mathematics	B.M. Stepanov O.I. Zavyalov

U S S R (cont'd)	MOSCOW, Research Institute of Nuclear Physics of the Moscow State University	S.N. Vernov N.P. Klepikov G.B. Khristiansen
	MOSCOW, Physical Faculty of the Moscow State University	A.A. Sokolov D.D. Ivanenko Yu.M. Shirokov
	MOSCOW Institute of Physical Engineering	V.G. Kirillov-Ugryumov A.M. Galper M.I. Ryazanov I.L. Rozental
	LENINGRAD, Research Institute of Electrophysical Apparatus	E.G. Komar I.F. Malyshev
	LENINGRAD, The Khlopin Institute of Radium	N.A. Perfilov
	LENINGRAD, Physical-Technical Institute of the USSR Academy of Science	S.P. Kruglov A.Z. Dolginov I.T. Dyatlov V.N. Gribov A.P. Komar M.V. Stabnakov I.M. Shmushkevich
	LENINGRAD Department of the V.A. Steklov Institute of Mathematics	L.D. Faddeyev
	LENINGRAD State University	Yu.V. Novozhilov M.A. Braun
	YEREVAN, Institute of Physics	A.I. Alikhanyan I.I. Goldman T.L. Asatiani Yu.F. Orlov F.R. Arutyunyan V.M. Kharitonov A.S. Aleksanyan V.A. Shakhbazyan G.A. Vartapetyan

U S S R (cont'd)	KHARKOV, Physical-Technical Institute	A.I. Akhiezer P.I. Vatset D.V. Volkov I.A. Grishayev P.V. Sorokin A.N. Fisun P.I. Fomin E.V. Inopin R.I. Kovtun
	SERPUKHOV, Institute of High Energy Physics	N.N. Bogolyubov A.A. Logunov Yu.D. Prokoshkin R.M. Sulyayev S.B. Nurushev S.P. Denisov A.V. Samoilov N.B. Alekseyev
	NOVOSIBIRSK, Institute of Nuclear Physics	G.I. Budker V.M. Galitsky S.T. Belyaev V.A. Sidorov B.V. Chirikov A.G. Khabakhpashev
	NOVOSIBIRSK, Institute of Mathematics	D.V. Shirkov
	KIEV, Institute of Physics of the Ukrainian Academy of Sciences	Yu.M. Maluta
	KIEV, Institute of Mathematics of the Ukrainian Academy of Sciences	O.S. Parasyuk
	TBILISI, Institute of Physics of the Georgian Academy of Sciences	G.E. Chikovani Z.Sh. Mandzhavidze S.G. Matinyan
	TBILISI, Physical Faculty of the Tbilisi State University	V.I. Mamasakhlisov I.Sh. Vashakidze
	ALMA-ATA, Institute of Nuclear Physics of the Kazakh Academy of Sciences	Zh.S. Takibayev P.A. Usak
	MINSK, Institute of Physics of the Byelorussian Academy of Sciences	A.A. Bogush

U S S R (cont'd)	TOMSK, Research Institute of Nuclear Physics, Electronics and Automatic Equipment of the Tomsk Polytechnical Institute	V.M. Kuznetsov V.A. Filimonov
	TASHKENT, Institute of Nuclear Physics of the Uzbek Academy of Sciences	S.A. Azimov U.G. Gulyamov
	UZHGOROD State University	Yu.M. Lomsadze

С С С Р	Об"единенный институт ядерных исследований	Блохинцев Д.И. Векслер В.И. Чувило И.В. Семенюшкин И.Н. Подгорецкий М.И. Любимов А.Л. Толстов К.Д. Соловьев М.И. Кузнецов А.А. Мороз И.В. Хачатурян М.Н. Копылов-Свиридов Р.А. Струнов Л.Н. Мальцев Э.И. Граменицкий И.М. Кладницкая Е.Н. Цыганов Э.Н. Лебедев Р.М. Никитин В.А. Ставинский В.С. Джелепов В.П. Понтекорво Б.М. Тяпкин А.А. Казаринов Ю.М. Мухин А.И. Лапидус Л.И. Мещеряков М.Г. Селиванов Г.И. Головин Б.М. Сидоров В.М. Щербаков Ю.А. Флягин В.Б. Петров Н.И. Сороко Л.М. Писарев А.Ф. Смородинский Я.А. Барашенков В.С. Соловьев В.Г. Огиевецкий В.И. Исаев П.С. Герштейн С.С. Тавхелидзе А.Н.
	Институт теоретической и экспериментальной физики ГКАЭ	Алиханов А.И. Владимирский В.В. Козодаев М.С. Никитин С.Я. Мешковский А.Г. Любимов В.А. Вайсенберг А.О. Померанчук И.Я. Окунь Л.Б. Иоффе Б.Л. Тер-Мартиросян К.А.

С С С Р	Институт теоретической и экспериментальной физики ГКАЭ (продолжение)	Шапиро И.С. Берестецкий В.Б. Рудик А.П. Кобзарев И.Ю. Гольдин Л.Л. Селектор Я.М. Левинтов И.И. Смолянкин В.Т. Елисеев Г.П. Мейман Н.С.
	Физический институт ГКАЭ СССР (Ереван)	Алиханян А.И. Гольдман И.И. Асатиани Т.Л. Орлов Ю.Ф. Арутюнян Ф.Р. Харитонов В.М. Алексанян А.С. Шахбазян В.А. Вартапетян Г.А.
	Физико-технический институт Академии наук УССР (Харьков)	Ахиезер А.И. Вацет П.И. Волков Д.В. Гришаев И.А. Сорокин П.В. Фисун А.Н. Фомин П.И. Инопин Е.В. Ковтун Р.И.
	Институт физики высоких энергий ГКАЭ	Боголюбов Н.Н. Логунов А.А. Прокошкин Ю.Д. Суляев Р.М. Нурушев С.Б. Денисов С.П. Самойлов А.В. Алексеев Н.В.
	Институт атомной энергии им. И.В. Курчатова	Мигдал А.Б. Мухин К.Н. Гуревич И.И. Немировский П.Э. Спивак П.Е.
	Научно-исследовательский институт электрофизической аппаратуры им. Д.В. Ефремова (г. Ленинград) ГКАЭ СССР	Комар Е.Г. Малышев И.Ф.

С С С Р	Радиевый институт им. Хлопина (г. Ленинград) АН СССР	Перфилов Н.А.
	Государственный комитет по использованию атомной энергии СССР	Гордеев В.Ф. Бурлаков В.Д. Мещеряков К.Н. Паников Л.П. Безруков Е.С. Афонин Г.С. Филиппов Д.П. Васильев В.А. Куракин А.Н. Лупандин О.С.
	Академия Наук СССР	Кулешов В.Ф.
	Физический институт АН СССР им. П.Н. Лебедева	Тамм И.Е. Балдин А.М. Фейнберг Е.Л. Фраджин В.С. Зацепин Г.Т. Черенков П.А. Марков Я. А. Дайон М.И. Петухов В. А. Чудаков А.Е. Славатинский С.А. Мазур Л.И. Монин А.С. Зельдович Я.Б. Исаков А.И.
	Физико-технический институт АН СССР им. А.Ф. Иоффе (Ленинград)	Круглов С.П. Долгинов А.З. Дятлов И.Т. Грибов В.Н. Комар А.П. Стабнаков М. П. Шмушкевич И.М.
	Институт ядерной физики Сибирского отделения АН СССР	Будкер Г.И. Галицкий В.М. Беляев С.Т. Сидоров В.А. Чириков Б.В. Хабахпашев А.Г.

С С С Р	Институт физики Академии наук Грузинской ССР	Чиковани Г.Е. Манджавидзе З.Ш. Матинян С.Г.
	Институт физических проблем Академии наук СССР	Халатников И.М. Дзялошинский И.Е.
	Математический институт им. В.А. Стеклова АН СССР	Степанов Б.М. Завьялов О.И.
	Институт ядерной физики Академии наук Казахской ССР	Такибаев Ж.С. Усак П.А.
	Институт ядерной физики Академии наук Узбекской ССР	Азимов С.А. Гулямов У.Г.
	Институт физики Академии наук Украинской ССР (г. Киев)	Малюта Ю.М.
	Институт физики Академии наук Белорусской ССР	Богуш А.А.
	Институт математики Сибирского отделения Академии наук СССР	Ширков Д.В.
	Институт математики Академии наук Украинской ССР	Парасюк О.С.
	Ленинградское отделение математического института им. В.А. Стеклова АН СССР	Фаддеев Л.Д.
	Научно-исследовательский ин-т ядерной физики Московского Государственного университета им. М.В. Ломоносова	Вернов С.Н. Клепиков Н.П. Христиансен Г.Б.

С С С Р	Физический факультет Московского Государственного университета им. М.В. Ломоносова	Соколов А.А. Иваненко Д.Д. Широков Ю.М.
	Московский инженерно-физический институт	Кириллов-Угрюмов В.Г. Гальпер А.М. Рязанов М.И. Розенталь И.Л.
	Научно-исследовательский институт ядерной физики, электроники и автоматики при Томском политехническом ин-те им. С.М. Кирова	Кузнецов В.М. Филимонов В.А.
	Ленинградский Государственный университет им. А.А. Жданова	Новожилов Ю.В. Браун М.А.
	Физический факультет Тбилисского государственного университета	Мамасахлисов В.И. Вашакидзе И.Ш.
	Ужгородский государственный университет	Ломсадзе Ю.М.

3. Программа
Programme

3

МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ ПО ФИЗИКЕ ВЫСОКИХ ЭНЕРГИЙ

Программа параллельных заседаний

Среда, 5 августа

	Секция А[x]	Секция Б[xx]
Утро		
9.30-10.15	Открытие конференции (в помещении Дома культуры)	
10.30-11.30	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Эксперимент Председатель: В.П.Джелепов	ОБЩИЕ ПРИНЦИПЫ ЛОКАЛЬНОЙ ТЕОРИИ Председатель: Л.Ван Хоф
11.45-12.45	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Эксперимент Председатель: В.П.Джелепов	ОБЩИЕ ПРИНЦИПЫ ЛОКАЛЬНОЙ ТЕОРИИ Председатель: Л.Ван Хоф
13.00-14.00	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Эксперимент Председатель: В.И.Векслер	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ Теория Председатель: В.К.Пановский
Вечер		
16.00-17.00	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Эксперимент Председатель: В.И.Векслер	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ Теория Председатель: В.К.Пановский
17.15-18.15	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Эксперимент Председатель: В.И.Векслер	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Теория Председатель: П.Мэтьюз
18.30-19.30	ПИОННЫЕ РЕЗОНАНСЫ Эксперимент Председатель: Щ.Пицейка	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Теория Председатель: П.Мэтьюз

x) Заседания секции А будут проходить в помещении Дома культуры.

xx) Заседания секции Б будут проходить в помещении Лаборатории теоретической физики.

Четверг, 6 августа

	Секция А	Секция Б
Утро		
9.30-11.45	ПИОННЫЕ РЕЗОНАНСЫ	МЕТОД КОМПЛЕКСНЫХ УГЛОВЫХ МОМЕНТОВ В ТЕОРИИ ПОЛЯ
	Эксперимент	
	Председатель: Щ.Цицейка	Председатель: И.Я.Померанчук
12.15-13.15	РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Теория
	Эксперимент	
	Председатель: Р.Адейр	Председатель: Б.В.Срекантан
Вечер		
15.00-16.00	РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Теория
	Эксперимент	
	Председатель: Р.Адейр	Председатель: Б.В.Срекантан
16.15-17.15	РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ	НОВЫЕ ИДЕИ
	Эксперимент	Председатель: И.Е.Тамм Секретари: Г.В.Ефимов В.Г.Кадышевский Б.В.Медведев В.Я.Файнберг
	Председатель: Р.Адейр	
17.30-18.30	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ	НОВЫЕ ИДЕИ
	Эксперимент	Председатель: И.Е.Тамм
	Председатель: Б.д' Эспанья	Секретари: Г.В.Ефимов В.Г.Кадышевский Б.В.Медведев В.Я.Файнберг

Пятница, 7 августа

Утро		
9.30-10.30	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ	СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ
	Эксперимент	Теория
	Председатель: Б.д' Эспанья	Председатель: Дж.Сакураи
10.45-11.45	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ	СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ
	Эксперимент	Теория
	Председатель: П.Будини	Председатель: Дж.Сакураи
12.15-13.15	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ	СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ
	Эксперимент	Теория
	Председатель: П.Будини	Председатель: Дж.Сакураи
Вечер		
15.00-16.00	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ ОБЫЧНЫХ ЧАСТИЦ
	Эксперимент	Эксперимент
	Председатель: П.Будини	Председатель: Р.Е.Маршак
16.15-18.30	ФИЗИКА СТРАННЫХ ЧАСТИЦ	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ
	Эксперимент	Теория
	Председатель: Г.А.Сноу	Председатель: Р.Гатто

ПРОГРАММА ПЛЕНАРНЫХ ЗАСЕДАНИЙ

			Председатель	Раппортер	Секретари
Понедельник, 10 августа					
Утро					
9.30–10.45	I.	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв) Эксперимент	Х.Бете	Д.М.Казаринов (Дубна)	Амаглобели Н.С. Василевский И.И. Кумекин Ю.П. Соколов С.Н.
11.00–12.15	II.	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (Выше I Гэв) Эксперимент	Е.М.МакМиллан	С.Дж.Линденбаум (Брукхейвен)	Бубелев З.Г. Галактионов Ю.В. Никитин В.А.
12.45–14.00	III.	ОБЩИЕ ПРИНЦИПЫ ЛОКАЛЬНОЙ ТЕОРИИ И ИХ ЭКСПЕРИМЕНТАЛЬНЫЕ СЛЕДСТВИЯ Теория	Н.Н.Боголюбов	А.А.Логунов (Серпухов)	Нгуен Ван Хьеу Поливанов М.К. Тодоров И.Т.
Вечер					
16.00–17.15	IV.	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв) Теория	М.Л.Гольдбергер	Д.В.Ширков (Новосибирск)	Ефремов А.В. Мещеряков В.А. Серебряков Р.С.
17.30–19.15	V.	ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв) Теория	Р.Е.Пайерлс	Е.Л.Фейнберг (Москва)	Мальцев В.М. Симонов В.А. Чернавский Д.С.
	VI.	МЕТОД КОМПЛЕКСНЫХ УГЛОВЫХ МОМЕНТОВ А В ТЕОРИИ ПОЛЯ	Р.Е.Пайерлс	В.Н.Грибов (Ленинград)	Азимов Я.И. Мурадян Р.М. Шураньи П.

Вторник, 11 августа		Председатель	Раппортер	Секретари
Утро				
9.30–10.45	УП. ПИОННЫЕ РЕЗОНАНСЫ Эксперимент	А.И.Алиханов	С.Я.Никитин (Москва)	Бунятов С.А. Ландсберг Л.Г. Мариш К. Шехтер В.М.
11.00–12.15	УШ. РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ Эксперимент	Гольдхабер Суламифь	Р.Арментерос (ЦЕРН)	Анисович В.В. Гешкенбейн Б.В. Копылов Г.И.
12.45–14.00	IX. ФИЗИКА СТРАННЫХ ЧАСТИЦ Эксперимент	Б.Грегори	Д.Миллер (Беркли)	Бирюсов Н.М. Иванов В.Г. Кузнецов Е.В.
Вечер				
16.00–17.15	X. СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ Теория	Дж.Швингер	А.Салам (Лондон)	Балуев Б.И. Ритус В.И. Фаустов Р.Н.
17.30–18.45	XI. ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ Эксперимент	Р.Хофштадтер	Н.Рамзей (Харвард)	Афанасьев Н.Г. Белоусов А.С. Ермолов П.Ф.

Среда, 12 августа			Председатель	Раппортер	Секретари
Утро					
9.30-10.45	XII.	ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ Теория	С.Дрелл	А.М.Балдин (Москва)	Байер В.Н. Лебедев А.И. Славнов А.А.
11.00-12.15	XIII.	ФИЗИКА НЕЙТРИНО Эксперимент	Б.М.Понтекорво	Е.Бернардини (ЦЕРН)	Евсеев В.С. Кафтанов В.С. Микаэлян Л.А.
12.45-14.30	XIV.	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ ОБЫЧНЫХ ЧАСТИЦ Эксперимент	В.Ф.Вайскопф	А.И.Мухин (Дубна)	Долинский Э.И. Никольский Б.А. Савченко О.В.
	XV.	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ Эксперимент	М.А.Марков	Чувило И.В. (Дубна)	Кузнецов Е.П. Оконов Э.О. Смирнитский В.А.
Вечер					
16.15-17.30	XVI.	СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ Теория	М.Гелл-Манн	А.Пайс (Нью-Йорк)	Биленький С.М. Кобзарев И.Ю. Рындин Р.М.
17.45-18.45	XVII.	ЗАКЛЮЧИТЕЛЬНОЕ ЗАСЕДАНИЕ	Д.И.Блохинцев		

НОВЫЕ МЕТОДЫ И ИДЕИ В ОБЛАСТИ АППАРАТУРЫ ДЛЯ ФИЗИКИ ВЫСОКИХ ЭНЕРГИЙ

Программа параллельных заседаний

Пятница, 14 августа

Утро
9.30-13.30

Секция А

ДЕТЕКТОРЫ ЧАСТИЦ ВЫСОКИХ ЭНЕРГИЙ

1) Газоразрядные и люминесцентные камеры

2) Черенковские и сцинтилляционные счетчики

3) Новые методы детектирования частиц.

Председатель: А.И.Алиханян

Секция Б

НОВОЕ В ТЕХНИКЕ ПУЗЫРЬКОВЫХ КАМЕР

Председатель: А.Г.Мешковский

Вечер
15.15-18.45

НОВОЕ В МЕТОДАХ ОБРАБОТКИ ИНФОРМАЦИИ, ПОЛУЧАЕМОЙ В ФИЗИЧЕСКИХ ЭКСПЕРИМЕНТАХ

1) Автоматическая обработка фотоснимков с пузырьковых и искровых трековых камер

2) Автоматизация процесса физических измерений (получение непосредственно в экспериментах цифровой информации, ее сбор и переработка).

Председатель: З.Феньвеш

МЕТОДЫ ПОЛУЧЕНИЯ И СЕПАРАЦИИ ПУЧКОВ ЧАСТИЦ ВЫСОКОЙ ЭНЕРГИИ

Председатель: Х.К.Тихо

Программа пленарных заседаний

Суббота, 15 августа		Председатель	Раппортер	Секретари
Утро				
9.30-11.15	НОВЕЙШЕЕ РАЗВИТИЕ МЕТОДА ИСКРОВЫХ И ЛЮМИНЕСЦЕНТНЫХ КАМЕР И СЧЕТЧИКОВ	Х.Л.Андерсон	А.А.Тяпкин (Дубна)	Долгошеин Б.А. Комаров В.И. Савин И.А.
11.45-13.30	НОВЫЕ ПРИНЦИПЫ И ПРИЕМЫ ОБРАБОТКИ ЭКСПЕРИМЕНТАЛЬНОЙ ИНФОРМАЦИИ	А.Лагари	И.Гольдшмидт-Клермон (ЦЕРН)	Коренченко С.М. Каржавин Ю.А. Моисеев Б.Н.
Вечер				
15.15-16.45	НОВОЕ В ТЕХНИКЕ ПУЗЫРЬКОВЫХ КАМЕР	Х.Р.Хильдебранд	Х.Филтут (ЦЕРН)	Будагов Ю.А. Зомбковский С.М. Шафранов М.Д.
17.15-18.45	МЕТОДЫ СЕПАРАЦИИ ЧАСТИЦ ВЫСОКИХ И СВЕРХВЫСОКИХ ЭНЕРГИЙ	В.В.Владимирский	М.Дойч (МТИ)	Антуфьев Ю.П. Миллер В.В. Требуховский Ю.В.

July 1964

1964 INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS IN DUBNA

C O N F E R E N C E T I M E T A B L E

PARALLEL SESSIONS

Wednesday, August 5

9.30a.m. - 10.15a.m.	OPENING OF THE CONFERENCE (at the Palace of Culture)	
	Section A[x]	Section B[xx]
10.30a.m.- 11.30a.m.	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV). Experimental Chairman: V.P.Dzhelepov	GENERAL PRINCIPLES OF THE LOCAL FIELD THEORY Chairman: L.Van Hove
11.45a.m.- 12.45a.m.	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV).Experimental Chairman: V.P.Dzhelepov	GENERAL PRINCIPLES OF THE LOCAL FIELD THEORY Chairman: L.Van Hove
1.00 p.m.- 2.00 p.m.	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Experimental Chairman: V.I.Veksler	ELECTROMAGNETIC INTERACTIONS Theoretical Chairman: W.K.H.Panofsky
4.00 p.m.- 5.00 p.m.	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Experimental Chairman: V.I.Veksler	ELECTROMAGNETIC INTERACTIONS Theoretical Chairman: W.K.H.Panofsky
5.15 p.m. - 6.15 p.m.	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Experimental Chairman: V.I.Veksler	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV). Theoretical Chairman: P.T.Matthews
6.30 p.m.- 7.30 p.m.	PION RESONANCES Experimental Chairman: S.Titeica	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV). Theoretical Chairman: P.T.Matthews

[x] Section A sessions will be held at the Palace of Culture

[xx] Section B sessions will be held at the Laboratory of Theoretical Physics

Thursday, August 6	Section A	Section B
9.30 a.m.- 11.45 a.m.	PION RESONANCES Experimental Chairman: S.Titeica	METHOD OF COMPLEX ANGULAR MOMENTA IN FIELD THEORY Chairman: I.Ya.Pomeranchuk
12.15a.m.- 1.15 p.m.	STRANGE PARTICLE RESONANCES Experimental Chairman: R.Adair	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Theoretical Chairman : B.V.Sreekantan
3.00 p.m.- 4.00 p.m.	STRANGE PARTICLE RESONANCES Experimental Chairman: R.Adair	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Theoretical Chairman: B.V.Sreekantan
4.15 p.m.- 5.15 p.m.	STRANGE PARTICLE RESONANCES Experimental Chairman: R.Adair	NEW IDEAS Chairman: I.E.Tamm Secretaries: G.V.Efimov V.G.Kadyshevsky B.V.Medvedev V.Ya.Fainberg
5.30 p.m.- 6.30 p.m.	WEAK INTERACTIONS OF STRANGE PARTICLES.Experimental Chairman: B.d'Espagnat	NEW IDEAS Chairman: I.E.Tamm Secretaries: G.V.Efimov V.G.Kadyshevsky B.V.Medvedev V.Ya.Fainberg

Friday, August 7	Section A	Section B
9.30 a.m.-10.30 a.m.	WEAK INTERACTIONS OF STRANGE PARTICLES . Experimental Chairman: B.d'Espagnat	STRONG INTERACTION SYMMETRIES Theoretical Chairman: J.J.Sakurai
10.45a.m.- 11.45 a.m.	ELECTROMAGNETIC INTERACTIONS Experimental Chairman: P.Budini	STRONG INTERACTION SYMMETRIES Theoretical Chairman: J.J.Sakurai
12.15 a.m.- 1.15 p.m.	ELECTROMAGNETIC INTERACTIONS Experimental Chairman: P.Budini	STRONG INTERACTION SYMMETRIES Theoretical Chairman: J.J.Sakurai
3.00 p.m. - 4.00 p.m.	ELECTROMAGNETIC INTERACTIONS Experimental Chairman: P.Budini	WEAK INTERACTIONS OF NON-STRANGE PARTICLES Experimental Chairman: R.E.Marshak
4.15 p.m. - 6.30 p.m.	STRANGE PARTICLE PHYSICS Experimental Chairman: G.A.Snow	WEAK INTERACTIONS Theoretical Chairman: R.E.Gatto

PLENARY SESSIONS

Monday, August 10		Chairman	Rapporteur	Secretaries
9.30 a.m.- 10.45 a.m.	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV) Experimental	H.Bethe	Yu.M.Kazarinov (Dubna)	Amaglobeli N.S. Kumekin Yu.P. Sokolov S. N. Vasilevsky I.M.
11.00a.m.- 12.15 a.m.	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV) Experimental	E.M.McMillan	S.J.Lindenbaum (Brookhaven)	Bubelev E.G. Galaktionov Yu.V. Nikitin V.A.
12.45a.m.- 2.00 p.m.	GENERAL PRINCIPLES OF THE LOCAL FIELD THEORY AND THEIR EXPERIMENTAL CONSEQUENCES	N.N.Bogolubov	A.A.Logunov (Serpukhov)	Nguyen Van Hieu Polivanov M.K. Todorov I.T.
4.00 p.m.- 5.15 p.m.	INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV) Theoretical	M.L.Goldberger	D.V.Shirkov (Novosibirsk)	Efremov A.V. Meshcheryakov V.A. Serebryakov V.S.
5.30 p.m.- 7.15 p.m.	INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV) Theoretical	R.E.Peierls	E.L.Feinberg	Chernavsky D.S. Maltsev V.M. Simonov V.A.
	METHOD OF COMPLEX ANGULAR MOMENTA IN FIELD THEORY	R.E.Peierls	V.N.Gribov (Leningrad)	Azimov Ya.I. Muradyan R.M. Shurany P.

Tuesday, August 11		Chairman	Rapporteur	Secretaries
9.30 a.m.- 10.45 a.m.	PION RESONANCES Experimental	A.I.Alikhanov	S.Ya.Nikitin	Bunyatov S.A. Landsberg L.G. Marish K. Shekhter V.M.
11.00a.m.- 12.15 a.m.	STRANGE PARTICLE RESONANCES Experimental	Sulamith Goldhaber	R.Armenteros (CERN)	Anisovich V.V. Geshkenbein B.V. Kopylov G.I.
12.45a.m.- 2.00 p.m.	STRANGE PARTICLE PHYSICS Experimental	B.Gregory	D.Miller (Berkeley)	Ivanov V.G. Kuznetsov E.V. Viryasov N.M.
4.00 p.m.- 5.15 p.m.	STRONG INTERACTION SYMMETRIES Theoretical	J.Schwinger	A.Salam (London)	Faustov R.N. Ritus V.I. Valuyev B.I.
5.30 p.m.- 6.45 p.m.	ELECTROMAGNETIC INTERACTIONS Experimental	R.Hofstadter	N.F.Ramsey (Harvard)	Afanasyev N.G. Belousov A.S. Ermolov P.F.

Wednesday, August 12		Chairman	Rapporteur	Secretaries
9.30 a.m.- 10.45 a.m.	ELECTROMAGNETIC INTERACTIONS Theoretical	S.Drell	A.M.Baldin (Moscow)	Bayer V.N. Lebedev A.I. Slavnov A.A.
11.00a.m.- 12.15 a.m.	NEUTRINO PHYSICS Experimental	B.M.Pontecorvo	G.Bernardini (C E R N)	Evseyev V.S. Kaftanov V.S. Mikaelyan L.A.
12.45a.m.- 2.30 p.m.	WEAK INTERACTIONS OF NON-STRANGE PARTICLES Experimental	V.F.Weisskopf	A.I.Mukhin (Dubna)	Dolinsky E.I. Nikolsky B.A. Savchenko O.V.
	" WEAK INTERACTIONS OF STRANGE PARTICLES. Experimental	M.A.Markov	I.V.Chuvilo (Dubna)	Kuznetsov E.P. Okonov E.O. Smirnitsky V.A.
4.15p.m.- 5.30 p.m.	WEAK INTERACTIONS Theoretical	M.Gell-Mann	A.Pais (New-York)	Bilenky S.M. Kobzaryev I.Yu. Ryndin R.M.
5.45 p.m.- 6.45 p.m.	CONCLUSIONS	D.I.Blokhintsev		

PLENARY SESSIONS

Saturday, August 15		Chairman	Rapporteur	Secretaries
9.30a.m.- 11.15 a.m.	ADVANCES IN SPARK AND LUMINESCENT CHAMBERS AND COUNTERS	H.L.Anderson	A.A.Tyapkin (Dubna)	Dolgoshein B.A. Komarov V.I. Savin I.A.
11.45a.m.- 1.30 p.m.	NEW PRINCIPLES AND METHODS IN EXPERIMENTAL DATA HANDLING	A.Lagarrigue	Y.Goldschmidt-Clermont (CERN)	Korenchenko S.M. Karzhavin Yu.A. Moiseyev B.N.
3.15p.m.- 4.45p.m.	ADVANCES IN BUBBLE CHAMBER TECHNIQUES	R.Hildebrand	H.Filthuth (CERN)	Budagov Yu.A. Shafranov M.D. Zombkovsky S.M.
5.15p.m.- 6.45 p.m.	SEPARATION METHODS FOR HIGH AND SUPERHIGH ENERGY PARTICLES	V.V.Vladimirsky	M.Deutsch (MIT)	Antufyev Yu.P. Miller V.V. Trebukhovsky Yu.V.

NEW METHODS AND IDEAS IN HIGH ENERGY PHYSICS INSTRUMENTATION

P A R A L L E L S E S S I O N S

Friday, August 14	Section A	Section B
9.30a.m.- 1.30 p.m.	HIGH ENERGY PARTICLE DETECTORS a)Discharge and luminescent chambers. b)Cherenkov and scintillation counters. c)New methods of particle detection. Chairman: A.I.Alikhanyan	ADVANCES IN BUBBLE CHAMBER TECHNIQUES Chairman: A.G.Meshkovsky
3.15 p.m.- 6.45 p.m.	ADVANCES IN DATA PROCESSING SYSTEMS FOR PHYSICAL EXPERIMENTS a)Automatic scanning and analysis of bubble and spark chamber photographs. b)Automation of measurement process in physics (digital information obtained direct from experiment, its accumulation and processing). Chairman: E.Fenyves	METHODS OF PRODUCTION AND SEPARATION OF HIGH ENERGY PARTICLE BEAMS Chairman: H.K.Ticho

4. Аннотации
Abstracts

4

ПЕРЕЧЕНЬ СЕКЦИЙ

I. ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Эксперимент

II. ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Эксперимент

III. ОБЩИЕ ПРИНЦИПЫ ЛОКАЛЬНОЙ ТЕОРИИ И ИХ ЭКСПЕРИМЕНТАЛЬНЫЕ СЛЕДСТВИЯ. Теория

IУ. ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв). Теория

У. ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв). Теория

УI. МЕТОД КОМПЛЕКСНЫХ УГЛОВЫХ МОМЕНТОВ В ТЕОРИИ ПОЛЯ

УII. ПИОННЫЕ РЕЗОНАНСЫ. Эксперимент

УIII. РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ. Эксперимент

IX. ФИЗИКА СТРАННЫХ ЧАСТИЦ. Эксперимент

X. СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ. Теория

XI. ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ. Эксперимент

XII. ЭЛЕКТРОМАГНИТНЫЕ ВЗАИМОДЕЙСТВИЯ. Теория

XIII. ФИЗИКА НЕЙТРИНО. Эксперимент

XIУ. СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ ОБЫЧНЫХ ЧАСТИЦ. Эксперимент

XУ. СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ. Эксперимент

XУI. СЛАБЫЕ ВЗАИМОДЕЙСТВИЯ. Теория

XУII. НОВЫЕ МЕТОДЫ И ИДЕИ В ОБЛАСТИ АППАРАТУРЫ ДЛЯ ФИЗИКИ ВЫСОКИХ ЭНЕРГИЙ

XУIII. НОВЕЙШЕЕ РАЗВИТИЕ МЕТОДА ИСКРОВЫХ И ЛЮМИНЕСЦЕНТНЫХ КАМЕР И СЧЕТЧИКОВ

XIX. НОВЫЕ ПРИНЦИПЫ И ПРИЕМЫ ОБРАБОТКИ ЭКСПЕРИМЕНТАЛЬНОЙ ИНФОРМАЦИИ

XX. НОВОЕ В ТЕХНИКЕ ПУЗЫРЬКОВЫХ КАМЕР

XXI. НОВЫЕ ИДЕИ И ПРИНЦИПЫ В ТЕХНИКЕ СЕПАРАЦИИ ЧАСТИЦ ВЫСОКИХ И СВЕРХВЫСОКИХ ЭНЕРГИЙ

LIST OF SECTIONS

I. INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV). Experimental

II. INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Experimental

III. GENERAL PRINCIPLES OF LOCAL FIELD THEORY AND THEIR EXPERIMENTAL CONSEQUENCES

IY. INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV). Theoretical

Y. INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV). Theoretical

YI. METHOD OF COMPLEX ANGULAR MOMENTA IN FIELD THEORY/

YII. PION RESONANCES. Experimental

YIII. STRANGE PARTICLE RESONANCES. Experimental

IX. STRANGE PARTICLE PHYSICS. Experimental

X. STRONG INTERACTION SYMMETRIES. Theoretical

XI. ELECTROMAGNETIC INTERACTIONS. Experimental

XII. ELECTROMAGNETIC INTERACTIONS. Theoretical

XIII. NEUTRINO PHYSICS

XIY. WEAK INTERACTIONS OF NON STRANGE PARTICLES. Experimental

XY. WEAK INTERACTIONS OF STRANGE PARTICLES. Experimental

XYI. WEAK INTERACTIONS. Theoretical

XYII. NEW METHODS AND IDEAS IN HIGH ENERGY PHYSICS INSTRUMENTATION

XYIII. ADVANCES IN SPARK AND LUMINESCENT CHAMBERS AND COUNTERS

XIX. NEW PRINCIPLES AND METHODS IN EXPERIMENTAL DATA HANDLING

XX. ADVANCES IN BUBBLE CHAMBER TECHNIQUES

XXI. NEW IDEAS AND PRINCIPLES IN BEAM SEPARATION TECHNIQUES FOR HIGH AND SUPERHIGH ENERGY PARTICLES

II

ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв)

Эксперимент

INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV)

Experimental

10-30 BeV/c ELASTIC SCATTERING OF $K^{\pm}$, $\bar{p}$, p, $\pi^{\pm}$ BY PROTONS*

K. J. Foley, R. S. Jones, R. S. Gilmore, S. J. Lindenbaum, W. A. Love, S. Ozaki, E. H. Willen, R. Yamada and L. C. L. Yuan

Brookhaven National Laboratory

This paper will report the preliminary results of a new series of elastic scattering experiments being performed at the Brookhaven AGS. Our previously described counter hodoscope on-line computer system which observes angular correlations of the two particles is again being used to select elastic scattering by measuring the angular correlation of scattered and recoil particles in the $|t|$ range 0.2 to 1.2.

The previous results for pions and protons will be extended to higher momentum (25-30 BeV/c). We also plan to obtain statistically significant results on shrinkage effects and other details of the behavior $K^{\pm}$-p and $\bar{p}$-p scattering and extend our observations to higher momenta (~20 BeV/c).

A new high resolution (~1 mr), high statistics (up to several hundred thousand elastic counts/hour) magnetic spectrometer counter hodoscope system employing a new high capacity digital data handling system with an on-line computer is being used to study small angle scattering (~1.5-25 mr) in great detail. We are also attempting to observe real amplitude effects directly by coulomb interference and also observe shrinkage effects down to much lower $|t|$ than previously obtained.

Differential elastic cross-sections, parametric fits and analyses of the available data will be presented.

УПРУГОЕ $n-p$ РАССЕЯНИЕ 5-7 ГЭВ/С.

Х.Хулубей, К.Бешлиу, Т.Бешлиу, А.Константинеску, М.Гаврилаш

Университет, Бухарест.

А.Михул, К.Поточеану

Институт Атомной физики, Бухарест

М. Телеман

Педагогический институт, Бухарест

Чжан Ванъ Юй, В.И.Мороз, И.А.Троиан, В.Ф. Вишневски, А.В. Никитин

О И Я И - Дубна

Измерено дифференциальное сечение упругого рассеяния нейтронов протонами.

Проанализировано около I2.000 фотоснимков, полученных при облучении 24 л. пропановой пузырьковой камеры пучком нейтронов с импульсом 5-7 Гэв/с, на синхрофазотроне ОИЯИ в Дубне.

Полученные результаты сравниваются с другими экспериментальными и теоретическими данными по упругому рассеянию.

ELASTIC NEUTRON - PROTON SCATTERING AT 5-7 GeV/c

H.Hulubei
C.Besliu, T.Besliu, A.Constantinescu, M.Gavrilas
Bucharest State University

A.Mihul, C.Potoceanu
Institute for Atomic Physics, Bucharest

M.Teleman - Pedagogycal Institute of Bucharest
Chang W-Y., V.I.Moroz, Yu.A.Troyan, V.F.Vishnevsky,
A.V.Nikitin - JINR (Dubna)

The elastic scattering differential cross-section for neutrons on protons has been measured.

About 12.000 bubble chamber pictures taken from the 24 l propan bubble chamber of the Joint Institute for Nuclear Research (Dubna) exposed to a neutron beam of momentum range 5-7 GeV/c were scanned.

The results are compared with other experimental and theoretical data on the n - p elastic scattering.

П-3

ИССЛЕДОВАНИЕ УПРУГОГО РАССЕЯНИЯ π МЕЗОНОВ НА ПРОТОНАХ С БОЛЬШОЙ ПЕРЕДАЧЕЙ ИМПУЛЬСА НУКЛОНУ ОТДАЧИ

И.А.Алиханов, Г.Л.Баятян, Э.В.Брахман, Ю.В. Галактионов, Г.П.Елисеев, О.Я.Зельдович, Л.Г. Ландсберг, В.А. Любимов.

Институт теоретической и экспериментальной физики, Москва, СССР.

Измеряется сечение упругого рассеяния π-мезонов на протонах на большие углы (обратное рассеяние) в интервале энергий 1,5-4,5 Gev. Выделение π-мезонов в пучке осуществляется с помощью двух газовых дифференциальных счетчиков. С помощью сигналов искровых счетчиков определяются углы рассеяния π-мезона и протона отдачи. Выделение факта передачи протону отдачи большого импульса при рассеянии осуществляется с помощью порогового газового черенковского счетчика.

Анализ протонов отдачи по импульсу осуществляется в 3-х метровом поворотном магните. Внутри магнита расположено 5 плоских однослойных искровых камер для определения траектории протонов в магнитном поле. Магнитный спектрометр позволяет определять импульс протонов отдачи с точностью ~4%.

Таким образом установка имеет несколько-кратную переопределенность для выделения кинематики упругого рассеяния.

В настоящее время измерения продолжаются.

INVESTIGATION OF π-MESON-PROTON ELASTIC SCATTERING WITH LARGE MOMENTUM TRANSFER TO THE RECOIL NUCLEON

A.I.Alikhanov, G.L.Bayatyan, E.V.Brakhman, Yu.V.Galaktionov, L.G.Landsberg, V.A.Lyubimov, G.P.Yeliseev, O.Ya.Zeldovich,

Institute for Theoretical and Experimental Physics, Moscow, U S S R

The large angles π-meson-proton elastic scattering cross section (backward scattering) is measured in the interval of the energies I,5-4,5 GeV . The separation in a beam is made by means of two gas differential counters. By means of spark counters signals the π-meson and recoil proton scattering angles are determined. The selection of large momentum transfer in scattering is obtained with the aid of the threshold gas Čerenkov counter.

The momenta recoil proton analysis is made by means of 3-meter turning magnet. Inside the magnet five flat one-layer spark chambers are placed to determine the protons trajectory in magnetic field. The magnetic spectrometer makes it possible to determine the recoil proton momenta with the accuracy of ~ 4%.

Thus the kinematics of the elastic scattering is considerably overdetermined.

The measurements are in progress.

П-4

ИССЛЕДОВАНИЕ УПРУГОГО $p-p$ РАССЕЯНИЯ В ОБЛАСТИ 2-7 ГЭВ.

Биргер Н.Г., Борисов В.С., Бышева Г.К.,
Гольдин Л.Л., Коротков М.М., Сидоренко З.С.,
Туманов Г.К.

Институт теоретической и экспериментальной физики, Москва,
СССР.

Измерено абсолютное сечение упругого $p-p$ рассеяния на угол 13^{0} в лабораторной системе координат в диапазоне 2 ÷ 7 Гэв. Измерения проведены на внутреннем пучке протонного синхротрона ИТЭФ с помощью электронной аппаратуры.

ELASTIC P-P SCATTERING AT 2-7 GEV

Birger N.G., Borisov W.S., Bysheva G.K., Goldin L.L.,
M.M.Korotkov, Sidorenko Z.S., Tumanov G.K.

Institute of Theoretical and Experimental Physics,
Moscow, USSR

Absolute value of the elastic proton-proton cross section at 130 laboratory angles has been measured. Measurements have been made using the internal proton beam in the energy interval 2-7 GeV of the ITEP proton synchrotron by means of electronics.

П-6

ПРЕДВАРИТЕЛЬНЫЕ ДАННЫЕ ПО ИССЛЕДОВАНИЮ УПРУГОГО p-p РАССЕЯНИЯ ПРИ МАЛЫХ ПЕРЕДАННЫХ ИМПУЛЬСАХ (t =0,0045 ÷ 0,03) И ЭНЕРГИЯХ 2-7 Бэв

В.П. Канавец, И.И. Левинтов, Б.В.Морозов
Н.А.Никифоров

Институт теоретической и экспериментальной физики,
Москва, СССР

Измерения проводились на синхрофазотроне ИТЭФ. Протоны пучка рассеивались на внутренней тонкой полиэтиленовой мишени. Для детектирования протонов отдачи применен полупроводниковый поверхностно-барьерный детектор. Случаи упругого p-p рассеяния выделялись по методу угол-энергия. Энерговыделение анализировалось по величине сигнала с детектора.

PRELIMINARY RESULTS OF THE INVESTIGATION OF ELASTIC pp SCATTERING AT SMALL MOMENTUM TRANSFER (t=0,0045 - 0,03) AND AT 2 - 7 GeV

V.P.Kanaveta, I.I.Levintov, B.V.Morosov, N.A.Nikiforov,

Institute for Theoretical and Experimental Physics,
Moscow, USSR

The measurement were carried out on the proton synchrotron of ITEP. The protons of the beam were scattered on the internal thin polythene target. A semiconductor surface-barrier detector was used to detect the recoil protons. The elastic pp scattering events were selected using the angle-energy technique. The energy yield was analized measuring the amplitude of the output signal of the detector.

П-7

ИССЛЕДОВАНИЕ УПРУГОГО p–p РАССЕЯНИЯ В ИНТЕРВАЛЕ ЭНЕРГИЙ 3–10 ГЭВ И ИНТЕРВАЛЕ ПЕРЕДАННЫХ ИМПУЛЬСОВ $t = -(0{,}08 \div 0{,}5)$.

В.П.Канавец, И.И.Левинтов, Б.В.Морозов, Н.А.Никифоров.

Институт теоретической и экспериментальной физики, Москва, СССР.

Измерялась относительная энергетическая зависимость дифференциального сечения $\left(\frac{d\sigma}{dt}\right)_{p-p}$ при четырех фиксированных значениях квадрата переданного четырехимпульса $/t/$. Рассеяние осуществлялось на внутренней полиэтиленовой мишени, вводимой в камеру синхрофазотрона ЛВЭ в районе выводного прямолинейного промежутка. Поток первичных частиц через мишень мониторировался с помощью миниатюрной ионизационной камеры с ксеноновым наполнением, прикрепленной к мишени. Для выделения случаев рассеяни на водороде использована однозначная кинематическая связь между углами вылета протона отдачи и его энергией. Энергия протонов отдачи определялась по ионизационному пробегу. При каждом значении $/t/$ сечения измерялись при энергиях 3; 4,5; 6,2; 8,5 и 10 Гэв.

Полные ошибки измерений в каждой точке не более 3%. (Статистические ошибки менее 1%). Наиболее сильная энергетическая зависимость наблюдалась при максимальных значениях $/t/$.

INVESTIGATION OF THE ELASTIC pp SCATTERING IN THE ENERGY REGION 3-10 GEV AND THE MOMENTUM TRANSFER REGION t= -(0,08 - 0,5)GeV

V.P.Kanavets, I.I.Levintov, B.V.Morosov, N.A.Nikiforov,
Institute for Theoretical and Experimental Physics
Moscow, USSR

Relative energy dependence of the differential cross-section $\left(\frac{d\sigma}{dt}\right)_{p-p}$ at four fixed values of the - 4-momentum transfer square t was measured. The scattering occured at an internal polythene target applied to the chamber of the LHE synchrophasotron in the region of the straight section.

The beam of the primary particles passing through the target was monitored using a small ionization chamber filled with Xe and attached to the target.

Definite kinematic relation between the angle of the recoil proton and its energy was used to identify the events of scattering on hydrogen nuclei. The recoil proton energy was determined by the ionization range.

At each value of t the cross section were measured at the energies of 3; 4,5; 6,2; 8,5 and 10 GeV.

Total errors of the measurements at the every point are not more than 3% (statistical errors less than 1%). The most strong energetical dependence was observed at the maximal values of t.

УПРУГОЕ ПРОТОН-ПРОТОННОЕ РАССЕЯНИЕ ПРИ I,45 Бэв

Кручинин С.П., Мухин К.Н., Романцева А.С.,
Светлолобов И.А., Сулковская М.М.,
Чуева С.А., Шляпников Р.С.

Институт атомной энергии им И.В.Курчатова,
Москва, СССР

До настоящей работы протон-протонное упругое рассеяние в интервале энергий I÷2 Бэв изучалось Брукхе венской Национальной лабораторией при энергиях I,5 Бэв (*P.R.* I03,I489) и I,35 Бэв (*P.R.* I28,I836). Исследование при энергии I,5 Бэв выполнено с помощью камеры Вильсона с малой статистикой (5I случай на весь интервал углов); исследование при энергии I,35 Бэв производилось системой счетчиков в ограниченном интервале углов от 6^0 до 45^0 в с.ц.м.

Настоящая работа имела целью восполнить недостатки существующих работ. Работа выполнена на материале опытного облучения пропановой пузырьковой камеры с импульсным магнитным полем. Камера облучалась пучком положительно заряженных частиц с импульсом 2,2 Бэв/с на I0 Бэв ускорителе ОИЯИ. Состав пучка: 47%-протоны, 47,5-пионы,3%-каоны и 2,5%-мюонов.

Полная длина просмотренных пучковых треков без учета взаимодействий равна 42,4 км. Найденные события обмерялись на полуавтоматической установке стереокомпараторного типа. Восстановление пространственной картины и кинематический анализ событий проводился на электронной вычислительной машине по специально составленной программе.

Получено дифференциальное сечение в интервале углов от $I5^0$ до 90^0 в с.ц.м. Однозначную идентификацию упругого (p-p)- рассеяния удалось провести в интервале углов от $\sim 45^0$ до 90^0 в с.ц.м. В интервале углов от $I5^0$ до 45^0 в с.ц.м. дифференциальное сечение получено методом вычитания ($\pi^- p$) -рассеяния, полученного в работе (*P.R.* I30, 762), выполненной в Лауренсевской Радиационной Лаборатории. Во всем исследованном интервале углов находится 400 случаев (pp) - рассеяний. Дифференциальное сечение упругого рассеяния было аппроксимировано с помощью оптической модели. Наилучшее совпадение с экспериментальными результатами дает радиус взаимодействия $R = 0{,}95\, f$. Из известного полного сечения взаимодействия протонов при данной энергии и оптической теоремы было получено полное сечение упругого рассеяния $\sigma_{el} = 20{,}2\ mb$.

ELASTIC PROTON-PROTON SCATTERING AT 1.45 BeV

Kruchinin S.P., Mukhin K.N., Romantzeva A.S., Svetlolobov I.A., Sulkovskaya M.M., Chueva S.A., Shlyapnikov R.S.

I.V.Kurchatov Institute of Atomic Energy
Moscow, USSR

The elastic proton-proton scattering within the 1 ÷ 2 BeV energy range was studied at Brookhaven National Laboratory at 1.5 BeV (P.R., 103, 1489) and 1.35 Bev (P.R., 128, 1836). The studies were carried out by a cloud chamber with small statistics (51 events per the full angular interval) and by a system of counters within the limited angular interval from 6° to 45° c.m., respectively.

The present work is purposed to complete the existing works. The experiment was carried out using the films of the tested exposition of the propane bubble chamber in a pulsed magnetic field. The chamber was exposed to a beam of positively charged 2,2 Bev /c particles on the 10 Bev accelerator of U.J.N.R. The beam consisted of 47% of protons, 47.5% of pions, 3.0% of kaons, and 2.5% of muons.

The full length of scanned beam tracks without taking into account interactions is 42.4 km. The found events were measured by a semiautomatic stereocomparator-typed device. The reconstruction of the spatial picture and kinematic analysis of the events were carried out by the computer according to specially programme.

A differential cross section in the angle range from 15° to 90° c.m. was obtained. We managed to carry out a simple identification of elastic (p-p) scattering in the angle range from 45° to 90° c.m.

In the angle range from 15° to 45° the differential cross section e was obtained by the subtraction of the (π, ρ)-scattering measured at Lawrence National Laboratory (PR 130, 762). There were 400 events of (p-p)-scatterings in the full examinated angle interval. The differential cross section of elastic scattering was approximated by the optical model. The best agreement with the experimental results was obtained by the interaction radius $R=0.95\,f$. From the known full cross section of interaction protons at this energy and optical theorem the full cross section of elastic scattering $\sigma_{el} = 20.2$ mb was obtained.

П-9

ИССЛЕДОВАНИЕ УПРУГОГО p-p РАССЕЯНИЯ ПРИ 24,5

Д. Бозоки, Е.Фенъвеш, Е.Томбоши, Т.Гемеши,
Ш. Красновски, Д. Пинтер, А.Шебештен, Ф.Телбис

Центральный институт физических исследований, Будапешт, Венгрия

Исследовалось дифференциальное сечение p-p рассеяния в 32-сантиметровой водородной пузырьковой камере ЦЕРНа. Импульс первичного протонного пучка имел значение $24,5 \pm 0,6$ *Gev/c* . Из примерно 6500 стереофотографий было выбрано 690 двухлучевых случаев. Измерения были произведены на микроскопе Zeiss U.M . Данные были обработаны на электронной вычислительной машине National Elliott 803. Было оценено полное упругое сечение, и дифференциальное упругое сечение уравнено с теоретическими предсказаниями Г.Домокоша.

II-9

INVESTIGATION OF THE ELASTIC p-p SCATTERING AT 24,5 GeV/c

G. Bozoki, E. Fenyves, E. Gombosi, T. Gemesy,
S. Krasznovsky, G. Pinter, A. Sebestyen,
F. Telbisz
Central Institute of Physical Research, Budapest,
Hungary

The differential cross section for p-p was investigated in the 32 cm. hydrogen bubble chamber of CERN. The momentum of the primary proton beam was 24,5 $\pm$ 0,6 GeV/c. From about 6500 stereo-pictures a sample of 690 two-prong events was selected. Measurements were carried out on Zeiss UM microscopes. The data were processed by means of a National Elliott 803 electronic computer. The total elastic cross section was estimated and the differential elastic cross section was compared with theoretical prediction given by Domokos.

П-10

УПРУГОЕ РАССЕЯНИЕ ЧАСТИЦ НА МАЛЫЕ УГЛЫ В БЭВНОЙ ОБЛАСТИ ЭНЕРГИЙ

А.Златева, З.Златанов, Х.Каназирски, П.Марков, Т.Тодоров, Х.Чернев,

Физический институт, София

Далхажав Н., Тувдендорж Д.,

Институт химии и физики, Улан-Батор.

Л.Кириллова, В.Никитин, А.Помофилов, В.Пантуев, В. Свиридов, И. Ситник, Л. Слепец, Л.Струнов, М. Хачатурян, Л. Христов, М.Шафранова

О И Я И, Дубна

З.Корбел и Л.Роб.

Высшее Техническое училище, Прага

Сообщаются результаты измерения дифференциального сечения упругого рассеяния П-мезонов на протонах при энергии 3,5 Гэв и протонов и дейтонах при энергиях 2,4,6,8 и 10 Гэв. Исследованная область переданных импульсов заключена в интервале $1{,}5 \cdot 10^{-3}$ Гэв/с $\leq t \leq$ 0,3 Гэв/с ^{2}. Из измерений интерференции кулоновской и ядерной амплитуд получены сведения о величине реальной части амплитуды рассеяния. Результаты экспериментов сравниваются с теорией упругого рассеяния, основанной на полюсах Редже.

ELASTIC SCATTERING OF PARTICLES ON SMALL ANGLES IN THE GeV-ENERGY REGION

A.Zlateva, Z.Zlatev, H.Kanazirski, P.Markov, T.Todorov and H.Chernev

Institute of Physics, Sofia

N.Dalkhazhav, D.Tuvdendorzh

Institute of Chemistry and Physics, Ulhan-Bator

L.Kirillova, V.Nikitin, A.Nomofilov, V.Pantuev, V.Sviridov, I.Sitnik, L.Slepets, L.Strunov, M.Khachaturian, L.Khristov, M.Shafranova

Joint Institute for Nuclear Research, Dubna

Z.Korbel and L.Rob

Technical College, Prague

Some results of the measurements of the differential cross section of the elastic proton-π-meson scattering at 3.5 GeV of the elastic proton-proton and proton-deuteron scattering at 2,4,6 and 10 GeV are presented. The transferred momentum region investigated lies in the interval $1.5.10^{-3}$ GeV/c $\leq t \leq$ o.3 $(GeV/c)^2$. From the measurements of the interference of Coulomb and nuclear amplitudes we have obtained some data concerning the magnitude of the real part of the scattering amplitude. The experimental results are compared with the theory of elastic scattering, based upon Regge poles.

PION-PROTON AND PROTON-PROTON ELASTIC SCATTERING AT 8.5, 12.4, AND 18.4 GeV/c

Scientific establishments in which the work has been carried out:

CERN, Geneva, Switzerland

Università di Bologna,
Istituto Nazionale di Fisica Nucleare, Sezione di Bologna

University of Liverpool,
Nuclear Physics Research Laboratory

University of Michigan,
The Harrison Randall Laboratory for Nuclear Studies

About 60000 diffraction scattering events of π^- p and pp-elastic scattering at 8.5, 12.4 and 18.4 GeV/c and of π^+ p at the lower two energies were collected in a spark chamber experiment at the CERN Proton Synchrotron. Using magnetic analysis of the incoming and diffraction scattered particle together with measurements of all angles, permitted each event to be determined to be elastic with three constraints, so that inelastic background was effectively rejected even at larger momentum transfers. The results, together with data from lower energies, confirm the remarkable energy independence of shape of the pion-proton diffraction scattering to momentum transfers of 1.5 $(GeV/c)^2$ over pion energies from 2 to 18 GeV. Proton-proton scattering does instead appear to show a shrinking diffraction peak. The data generally agree with other (counter and bubble chamber) experiments, though some differences do appear. During the experiment, data were taken which set an upper limit on the differential elastic cross-section from 140^0 to 163^0 at 13.4 GeV/c, on the polarization of the recoil proton in the diffraction region at 8 GeV/c and on inelastic scattering. Most of this data has been processed by the CERN Automatic Flying Spot Digitizer (HPD).

ФОРМА ИМПУЛЬСНОГО СПЕКТРА БАРИОНОВ В СТОЛКНОВЕНИЯХ БЫСТРЫХ ЧАСТИЦ

К.Д.Толстов

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Показано, что поперечный импульс барионов в упругом p-p рассеянии [I] , ри.с I и неупругих $\pi^- N$ столкновениях [2], [3] хорошо апроксимируется формулой:

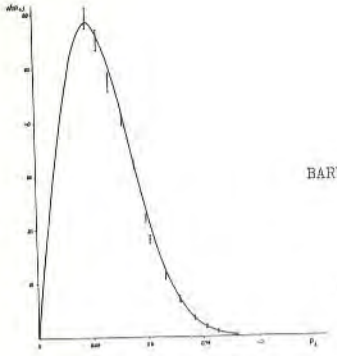
$$W(p_\perp) = \frac{2 p_\perp}{\langle p_\perp \rangle^{1/2}} \, e^{-\frac{p_\perp^2}{\langle p_\perp^2 \rangle}}$$

Продольный импульс барионов в неупругих $\pi^- N$ - столкновениях согласуется с гауссовым распределением. В соответствии с этим, следуя Гайзенбергу, предполагается, что в неупругих взаимодействиях принцип неопределенности справедлив со знаком равенства и независимость поперечного импульса нуклонов от энергии и массы первичных частиц объясняется постоянством области взаимодействия: $\langle r_\perp^2 \rangle^{1/2} = (0{,}46 \pm 0{,}05)$ фм . Область взаимодействия в продольном направлении должна испытывать Лоренцовское сокращение, следовательно:

$$\frac{2 \langle \Delta p_\parallel^2 \rangle^{1/2}}{\langle p_\perp^2 \rangle^{1/2}} = \gamma_c$$

В таблице приведены расчеты по этой формуле и опытные данные.

Энергия в Бэв	вторичная частица	γ_c	
		Расчетное	Известное
4	протон	I,95	I,7
7	-"-	2,34±0,35	2,I
I6	-"-	2,54±0,6	3
7,5		2,6 ± 0,2	2,2



BARYON MOMENTUM SPECTRUM SHAPE IN FAST PARTICLE COLLISIONS

K.D. Tolstov

Joint Institute for Nuclear Research
Laboratory of High Energies

It is shown that the baryon transverse momentum in elastic p-p scattering (1) Fig. (I) and in inelastic $\pi^- - \mathcal{N}$ collisions (2), (3) is approximated well by the formula:

$$W(p_\perp) = 2\, p_\perp \langle p_\perp^2 \rangle^{-1/2} \cdot \exp\left(-p_\perp^2 / \langle p_\perp^2 \rangle\right).$$

The baryon longitudinal momentum in inelatic $\pi^- - \mathcal{N}$ collidions agrees with the Gussian distribution. In accordance with this, following Heisenberg, it is assumed that in inelastic interactions the uncertainty principle is valid with the sign of equality, and the indopendence of nucleon transverse momentum of the energy and initial particle mass is explained by the interaction range constancy $\langle r_\perp^2 \rangle^{1/2} = (0.46 \pm 0.05)$ fm.

The interaction range in the longitudinal direction should undergo the Lorentz contraction, therefore: $2 \langle \Delta p_\parallel^2 \rangle^{1/2} \cdot \langle p_\perp^2 \rangle^{-1/2} = \gamma_c$

Experimental data and calculations after this formula are shown in the following table

Energy in BeV	Secondary particle	calculated	known
4	proton	1.95	1.7
7	proton	2.34 ± 0.35	2.1
16	proton	2.54 ± 0.6	3
7.5	Λ	2.6 ± 0.2	2.2

References

1. K. Foley, S. Lidnenbaum et. al. Phys. Rev. Let. II, 503 (1963)
2. V.A. Beliakov et. al. JETP, 39, 937 (1960)
3. V.A. Beliakov et. al. Preprint JINR D-1105 (1962)

PROTON-PROTON ELASTIC SCATTERING*

A. R. Clyde, Bruce Cork, D. Keefe, L. T. Kerth,
W. M. Layson, and W. A. Wenzel

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 21, 1964

Differential cross-sections for elastic proton-proton scattering have been measured for incident momenta of 3, 5, and 7 Gev/c. The protons scattered backwards in the CM system are detected with scintillation counters following analysis with a magnetic spectrometer. Polyethylene and carbon targets were used for scattered momenta above 500 Mev/c, and a gaseous hydrogen target was used for scattered momenta below 600 Mev/c. With a few exceptions, the statistical errors are smaller than 1% for the lower momentum transfers, and increase to 5% for 90° scattering in the center of mass. The cross sections at high momentum transfer are nearly independent of momentum transfer but depend on incident energy. This result is consistent with experiments at higher energy.

*Work done under the auspices of the U. S. Atomic Energy Commission.

The Real Part of the Forward Amplitude in Proton-Proton Scattering at 1.7 GeV/c

J.D. Dowell, P.J. Homer, Q.H. Khan, W.K. McFarlane, J.S.C. McKee and A.W. O'Dell

---

Final results of proton-proton elastic scattering in the angular region 1.25° to 5° lab. show a negligible amount of Coulomb interference with an error of $\pm$ 6%. The excess of the forward differential cross section above the optical theorem limit must therefore be caused by a large spin-dependent amplitude which is mainly imaginary. Good agreement is found with calculations of the real part of the spin-independent amplitude from dispersion relations [1] which show that the real part changes sign at 1.7 GeV/c giving constructive interference at higher energies. Results for the real part obtained from Coulomb interference at other energies are also shown and follow qualitatively the behaviour found from the calculation.

(1) P. Söding, Phys. Lett. 8, 285 (1964)

PROTON -PROTON SCATTERING AT VERY SMALL ANGLES

E. Lohrmann and M. Meyer
II. Inst. f. Experimentalphysik der Universität Hamburg and DESY, Hamburg

and H. Winzeler
CERN, Geneva

The differential cross section for elastic p-p scattering was measured for values of the momentum transfer between 40 MeV/c and 200 MeV/c, using a hydrogen gas target in the fast ejected beam of the CERN PS and nuclear emulsions as detector. The momentum of the incident protons was 24 GeV/c. Results on the cross section, particularly in the region of the interference between the real part of the scattering amplitude and the Coulomb amplitude, will be presented and the implications for the real part of the scattering amplitude will be discussed.

p-p ELASTIC SCATTERING AT HIGH ENERGY

G.Baroni, A.Manfredini, V.Rossi

Istituto di Fisica dell'Università - Roma
I.N.F.N. Sezione di Roma

and

M.Ferro Luzzi - CERN

The proton-proton elastic scattering has been investigated by means of the detection of the recoil proton.

The experimental set-up is similar to that already described by B.Bakker et al., at the 1962 Geneva Conference.

The present result refers to the $-t$ interval between 5×10^{-3} - 5×10^{-2} $(GeV/c)^2$ and for the primary's energies of 10, 19 and 27.5 GeV.

Small Angle p-p scattering at 7.8 GeV/c

A. E. Taylor and I. L. Watkins
Atomic Energy Research Establishment

A. Ashmore, W. S. Chapman, D. F. Falla, W. H. Range and D. B. Scott,
Queen Mary College, London

A. Astbury, F. Capocci, J. F. Crawford, M. Sproul and T. G. Walker
Rutherford High Energy Laboratory.

The paper will present measurements of the differential p-p elastic scattering cross sections in the laboratory range of angles 4-30 mrad for 7.8 GeV/c incident protons obtain from NIMROD. The method employed consisted of six sonic spark chambers to measure the incoming proton momentum and direction and the outgoing momentum and direction after scattering from a liquid Hydrogen target. The data will be analysed for the presence of any real part of the forward scattering amplitude and the amount by which this exceeds the optical limit.

TRANSVERSE MOMENTUM DISTRIBUTIONS IN HIGH ENERGY P-P SCATTERING

Jay Orear, Laboratory of Nuclear Studies, Cornell University, Ithaca, N.Y.

A simple functional form has been found which fits quite well all the high-energy, large-angle P-P elastic scattering cross sections measured by the Cornell-Brookhaven group at the Brookhaven AGS. These 29 differential cross sections which cover 10 to 30 Bev and center of mass angles from 30° to 90° show both a strong energy dependence and angle dependence. This two variable dependence can be fit quite well by a simple exponential in one variable, the transverse momentum. The least squares determined fit is

$$\frac{d\sigma}{d\omega} = A\, e^{-p_\perp/p_o}$$

where A = 34 mb/sr, p_o=151 Mev/c and $p_\perp = p \sin\theta$.

Perhaps it is more than a coincidence that the transverse momentum distribution of pions produced by nucleon-nucleon collisions can also be fit by $e^{-p_\perp/p_o}$ where $p_o \approx 170$ Mev/c. An even closer fit to the 29 P-P scattering cross sections is obtained by using

$$\frac{d\sigma}{d\omega} = \frac{A}{s}\, e^{-b/p_o}$$

where A = 595 mb/sr, p_o= 158 Mev/c and s, the c.m. total energy squared is in Bev^2. Functions of the form $e^{-\alpha/p_\perp \log s/s_o}$ as suggested by Kinoshita and Yamamoto cannot be made to fit all the data unless $s_o \sim 10^{-30}$ Bev^2.

The 1964 International Conference on High Energy Physics

10-30 BeV/c ELASTIC SCATTERING OF $K^{\pm}$, $\bar{p}$, p, $\pi^{\pm}$ BY PROTONS*

K. J. Foley, R. S. Jones, R. S. Gilmore, S. J. Lindenbaum, W. A. Love, S. Ozaki, E. H. Willen, R. Yamada and L. C. L. Yuan

Brookhaven National Laboratory

This paper will report the preliminary results of a new series of elastic scattering experiments being performed at the Brookhaven AGS. Our previously described counter hodoscope on-line computer system which observes angular correlations of the two particles is again being used to select elastic scattering by measuring the angular correlation of scattered and recoil particles in the $|t|$ range 0.2 to 1.2.

The previous results for pions and protons will be extended to higher momentum (25-30 BeV/c). We also plan to obtain statistically significant results on shrinkage effects and other details of the behavior $K^{\pm}$-p and $\bar{p}$-p scattering and extend our observations to higher momenta (~20 BeV/c).

A new high resolution (~1 mr), high statistics (up to several hundred thousand elastic counts/hour) magnetic spectrometer counter hodoscope system employing a new high capacity digital data handling system with an on-line computer is being used to study small angle scattering (~1.5-25 mr) in great detail. We are also attempting to observe real amplitude effects directly by coulomb interference and also observe shrinkage effects down to much lower $|t|$ than previously obtained.

Differential elastic cross-sections, parametric fits and analyses of the available data will be presented.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

NEUTRON-PROTON ELASTIC CHARGE EXCHANGE SCATTERING AT 8 GEV/C

G. Manning, A. G. Parham
A.E.R.E., Harwell, England
J. D. Jafar, H. B. van der Raay, D. H. Reading, D. Ryan,
University of Birmingham
B. D. Jones, J. Malos,
H.H. Wills Physics Laboratory, University of Bristol
N. H. Lipman
Rutherford High Energy Laboratory

Measurements of n-p charge exchange scattering have been made, using a neutron beam taken at 0° from an internal target in the Nimrod proton synchrotron. This beam was incident on a 60 cm. hydrogen target, and a detector system consisting of a gas Cerenkov counter, a 3 m. bending magnet and sonic spark chambers measured the angle of production and the momentum of protons from the charge exchange interaction. A peak in the momentum spectrum corresponding to elastic charge exchange production of the beam neutrons followed by elastic charge exchange scattering of the neutrons in the hydrogen target, was clearly separated from the inelastic background.

Data will be presented on the angular distribution of the protons from elastic charge exchange at 8 GeV/c, over the angular range 0-45 mr.

π^--p CHARGE EXCHANGE AND INVERSE PHOTOPRODUCTION AT 10 GEV/c

G.Backenstoss, B.D.Hyams, W.Manner, A.Reale, U.Stierlin
CERN Geneva 23, Switzerland

Preliminary experimental results will be presented on the reaction

$$\pi^- + p \rightarrow \pi^0 + N$$
$$\pi^- + \rho \rightarrow \gamma + N$$

at 10 Gev/c.

П-22

ОЦЕНКА СЕЧЕНИЯ ПЕРЕЗАРЯДКИ Π^--МЕЗОНОВ НА КВАЗИСВОБОДНЫХ ПРОТОНАХ ПРИ 9 ГЭВ

И.М.Граменицкий, Л.С. Охрименко, Б.Словинский, З.С. Стругальский[x)]

Объединенный институт ядерных исследований
Дубна

На 55000 снимках, полученных в ксеноновой пузырьковой камере, облученной пучком Π^--мезонов 9 Гэв/с, обнаружен 21 случай 0-лучевых взаимодействий с двумя γ - квантами, которые не противоречат кинематике реакции упругой перезарядки $\pi^- + p_{Xe} \to \pi^0 + n_{Xe}$. Это соответствует сечению на ядро ксенона $\sigma^{Xe} = (0{,}82 \pm 0{,}18)$ мб, что эквивалентно сечению на квазисвободный протон $\sigma = (0{,}09 \pm 0.02)$ мб.

Проведена оценка фона от неупругих событий с рождением медленного П-мезона, поглощенного ядром, которые визуально имитируют реакцию перезарядки. Учет фона, вызванного этими процессами, приводит в величине сечения упругого обменного рассеяния на квазисвободном протоне $\sigma_{ex} = (0{,}04 \pm 0{,}02)$ мб.

---

x) Институт ядерных исследований, Варшава.

THE ESTIMATION OF THE CHARGE-EXCHANGE CROSS SECTION OF 9 GeV/c π^- MESONS ON QUASI-FREE PROTONS

I.M.Gramenitsky, L.S.Okhrimenko, B.Slovinski, Z.B.Strugalski*

Joint Institute for Nuclear Research

* Institute for Nuclear Research, Warsaw, Poland

In 55000 pictures obtained in a Xenon bubble chamber exposed to 9 GeV/c π^- beam, there were found 21 zero-prong stars with two γ-quanta in which kinematics do not disegree with elastic charge exchange:

$$\pi^- + p_{Xe} \longrightarrow \pi^0 + n_{Xe}$$

This correcponds to cross section on Xe $\sigma_{Xe} = (0.82 \pm 0.18)$ mb equivalent to the cross section on quasi-free proton $\sigma = (0.09 \pm 0.02)$. It has been done an estimation of background from inelastic events which looks like charge exchange if slow π^- mesons are absorbed in nucleus. Taking account into the background one obtains the cross section for elastic scattering exchange on quasi- free proton

$\sigma_{ex} = (0.04 \pm 0.02)$ mb .

П-23

МНОЖЕСТВЕННОЕ РОЖДЕНИЕ МЕЗОНОВ ТЯЖЕЛЫМИ ПЕРВИЧНЫМИ ИЗ КОСМИЧЕСКОГО ИЗЛУЧЕНИЯ И ПРОДУКТАМИ ИХ ФРАГМЕНТАЦИИ С ЭНЕРГИЕЙ 10^{12} эв

Ф.Абрахам, Е.Геруля, Р.Леви-Сетти, К.Рыбицки, Ц.Х. Тсао

Университет - Чикаго,

В.Вольтер

Институт ядерных исследований - Краков, Польша

Р.Л.Фриккен, Р.В. Хаггетт

Государственный университет в Луизьяне

Батон Руж

Сделан анализ струй, образованных первичными тяжелыми ядрами, пользуясь проживающими продуктами фрагментации как осями отношения. Геометрические соотношения между вторичными и третьестепенными частицами можно получить для углов вылета $>10^{-5}$ радиана.

Безбаясное число взаимодействий заряженных фрагментов получено методом просмотра вдоль треков. Нейтральные взаимодействия обнаруживались с большой эффективностью. Будет показано, что ряд разногласных свойств анализа струй зарожденных одно-заряженными первичными можно выяснить в настоящем исследовании.

MULTIPLE MESON PRODUCTION BY HEAVY PRIMARY OF COSMIC RADIATION AND THEIR FRAGMENTATION PRODUCTS OF ENERGIES ABOVE 10^{12} eV

F.Abraham, J.Gierula, R.Levi-Setti, K.Rybicki, C.H.Tsao
The University of Chicago, USA

W.Wolter
Institute of Nuclear Research, Krakow, Poland

R.L.Fricken, R.W.Huggett
Louisiana State University, Baton Rouge

Jets produced by primary heavy nuclei were recently analyzed using the surviving fragmentation products as the reference axis for accurate angular measurements. The geometrical relationships between all secondary and tertiary particles could be obtained for emission angles of 10^{-5} radian.

An unbiased sample of charged-fragment interactions was obtained by track tracing. Neutral interactions were detected with a high efficiency. It will be shown that several controversial features of the analysis of singly-charged, primary-induced jets are clarified in the present investigation.

П-24

СЕЧЕНИЕ НЕУПРУГОГО ($n - \rho$) ВЗАИМОДЕЙСТВИЯ ПРИ ЭНЕРГИИ ~30 и ~60 ГЭВ

Г. Бозоки, Э.Фенъвеш

Центральный институт физических исследований,
Будапешт, Венгрия

Н. Ахабабян, Б.Бетев, Щ.Кавляков

Физический институт Болгарской Академии наук,
София, Болгария

С помощью годоскопированной счетчиковой установки, работающей на уровне гор, измеряется средний свободный пробег для неупругого взаимодействия нейтронов космического излучения в графите и парафине. Применяя дифференциальный метод CH_2-C, определяется величина сечения для неупругого ($n-\rho$) взаимодействия при различных энергиях. Сообщаются предварительные результаты при средних энергиях ~30 и ~60 Гэв.

INELASTIC (n-p) CROSS-SECTION AT ~ 30 AND ~ 60 GEV

G.Bozóki, E.Fenyves
Central Research Institut of Physics, Budapest, Hungary

N.Ahababian, B.Betev, St.Kavlakov
Institut of Physics of the Bulgarian Academy of Sciences
Sofia, Bulgaria

The attenuation of penetrating shower producing cosmic ray neutrons in paraffin and graphite is measured with a counter hodoscope arrangement at mountain altitude. By the CH_2- C substraction method the values of the inelastic (n-p) cross section are determined at different energies. Preliminary results are given for average energies of about 30 and 60 GeV.

П-25

ИССЛЕДОВАНИЕ СПЕКТРА МАСС ПАР ЗАРЯЖЕННЫХ ЧАСТИЦ В $\pi^- N$ ВЗАИМОДЕЙСТВИЯХ ПРИ ЭНЕРГИИ 7 и I7 Бэв

А.Х.Виницкий, А.А. Локтионов,
Ж.С.Такибаев, И.Я. Часников

Институт ядерной физики АН Казахской ССР

Для анализа используются $\pi^- N$ - взаимодействия, образованные в фотоэмульсии. Идентификация частиц производилась путем измерения кулоновского рассеяния и ионизации. Так как доля высокоэнергичных протонов на одно взаимодействие мала ($\sim$ 0,I - 0,2), все неидентифицированные частицы считались пионами. Импульс таких частиц определялся методом Монте-Карло.

В результате получен спектр масс $\pi\pi$ и πN пар для всех заряженных частиц. Изучается зависимость вида полученного распределения от первичной энергии и величины передаваемого четырехмерного импульса.

MASS SPECTRUM INVESTIGATION OF CHARGED PARTICLE PAIRS IN π^--N-INTERACTIONS AT 7 AND 17 GeV

A.H.Vinitsky, A.A.Loktionov, Zh.S.Takibayev, U.Ya.Chasnikov

Institute of Nuclear Physics, Academy of Sciences, Kazakh SSR

The π^- - N interactions produced in photoemulsion are used for an analysis. The particles were indentified by measuring the Coulomb scattering and ionization. As the fraction of high-energy protons per one interaction is small (~0,1 - 0,2), all of the nonindentified particles were considered as pions. The momentum of such particles is determined by the Monte-Carlo method.

As a result, the mass spectrum of $\pi\pi$ and πN pairs for all of the charged particles is found. The obtained distribution mode dependence upon the primary energy and the value of a transmitted four-dimensional pulse is under study.

П-26

ЭМИССИЯ БЫСТРЫХ ГЕЛИЕВЫХ ЧАСТИЦ ПРИ ВЗАИМОДЕЙСТВИИ ПИОНОВ И НУКЛОНОВ ВЫШЕ 10^{10} ЭВ С ЯДРАМИ.

Ж.С. Такибаев, Г.А. Тлеубергенова,
Е.В. Шалагина

Казахский Государственный университет им. С.М.Кирова
С С С Р

Работа посвящена изучению явления испускания гелиевых частиц с кинетической энергией больше 100 Мэв, образованных во взаимодействиях пионов энергии 17,5 Бэв с ядрами фотоэмульсии.

Анализируются угловые и энергетические характеристики, а также сечения вылета двухзарядных частиц в сравнении с ранее получаемыми данными при энергии первичных частиц 10 Бэв.

Угловые распределения гелиевых частиц в Л-системе резко анизотропны, причем степень анизотропии растет с ростом энергии этих частиц.

Анализ энергетических распределений указывает на отсутствие заметной зависимости энергетического спектра гелиевых частиц от энергии бомбардирующих частиц в пределах 10-20 Бэв. Не обнаружено сколько-нибудь заметного изменения максимальной энергии гелиевых частиц в протонных взаимодействиях с увеличением энергии первичных протонов. В случае П-мезонных взаимодействий наблюдается большой рост (20-30%) максимальной энергии двухзарядных частиц с ростом энергии первичных пионов в интервале 10-20 Бэв.

Эксперимент показывает, что с ростом энергии первичного протона сечение образования гелиевых частиц с кинетической энергией более 100 Мэв в пределах ошибок не изменяется, тогда как в случае П-мезонов сечения взаимодействия для образования двухзарядных частиц возрастает.

EMISSION OF FAST HELIUM PARTICLES IN 10^{10} eV PION-NUCLEON INTERACTION WITH NUCLEI

Zh.C.Takhibayev, G.A.Tleubergenova, E.B.Shalagina

S.M.Kirov State University Kazakh.SSR

The emission of helium particles of a kinetic energy higher than 100 MeV produced in 17.5 GeV pion interaction with photoemulsion nuclei is investigated.

Angular and energy characteristics as well as the cross sections of doubly charged particle emission are compared to earlier obtained data for the primary particle energy of 10 GeV.

The angular distributions of helium-particles in the lab.system are sharply anisotropic, the degree of anisotropy being increased with increasing the energy of these particles.

The analysis of energy distributions shows the absence of noticeable dependence of the energy spectrum of helium particles upon incident particle energy in the energy range of 10-20 GeV. There was not found any even slightly noticeable variation of the maximum energy of helium particles in proton interactions with increasing primary proton energy. In the case of pion interactions there is a considerable increase (20 - 30%) of the maximum energy of doubly charged particles with increasing primary pion energy in the energy range from 1 to 20 GeV.

The experiment shows that with increasing primary proton energy the cross section of helium particle production with a kinetic energy over 100 MeV is not changed within errors, while in the case of pions the interaction cross sections for doubly-charged particles is increased.

П-27

О НЕКОТОРЫХ ОСОБЕННОСТЯХ ПИОН-НУКЛОННЫХ И НУКЛОН-НУКЛОННЫХ НЕУПРУГИХ ВЗАИМОДЕЙСТВИЙ

Э.Г. Боос, А.Х. Виницкий,
Ж.С. Такибаев, И.Я. Часников

Институт ядерной физики АН Казахской ССР

Приводятся данные об угловых и энергетических характеристиках вторичных частиц из $p - N$ и $\pi^- - N$ – взаимодействий при энергиях (9–20) Бэв и (7,5–I7) Бэв соответственно.

С помощью фотоэмульсионной методики проидентифицированы заряженные частицы во всем энергетическом интервале, что дало возможность получить детальную информацию о высокоэнергичной части импульсного спектра вторичных протонов и других заряженных частиц.

В распределениях по квадрату четырехмерного импульса, передаваемому нуклону, наблюдаются два максимума в области больших и малых значений Δ^2 как для $\pi - N$, так и для $p - n$ – взаимодействий. Исходя из этого оценивается вклад периферических и центральных соударений.

Анализ показал большую вероятность перезарядки нуклонов при неупругих соударениях. В процессе перезарядки нуклонов преобладают большие передачи четырехмерных импульсов.

ON SOME PECULIARITIES OF PION-NUCLEON AND NUCLEON-NUCLEON INELASTIC INTERACTIONS

E.G.Boos, A.Kh.Vinitsky, G.S.Takibaev, I.Ya.Chasnikov

The Institute of Nuclear Physics Academy of Sciences,
Kazakh SSR

Information is given on the angular and energy characteristics of secondary particles from P-N and π^--N-interactions at 9-20 GeV and 7.5 - 17 GeV, respectively.

Charged particles have been identified over the whole energy spectrum, which made it possible to obtain detailed information on the high energy fraction of the momentum spectrum of secondary protons and other charged particles.

Two maxima are observed in the region of large and small values of Δ^2 both for π^--N - and p-n - interactions in the distributions over the square four-dimensional momentum transferred to the nucleon.

Thus, the contribution of peripheral and central collisions is estimated.

The analysis has shown the great probability of nucleon charge exchange in inelastic collisions. Large four-dimensional momentum transfers are predominant in nucleon charge exchange.

П-28

ИССЛЕДОВАНИЕ УГЛОВЫХ ХАРАКТЕРИСТИК p-ν ВЗАИМОДЕЙСТВИЙ ПРИ ЭНЕРГИИ 20 Гэв.

Э.Г.Боос, Н.П.Павлова, Ж.С.Такибаев,
Р.А. Турсунов.

Институт ядерной физики АН Казахской ССР

В эмульсии отобрано 1035 взаимодействий протонов на свободных и квазисвободных нуклонах. Из сравнения лучевых распределений для p-p – взаимодействий с соответствующими данными, полученными в пузырьковой камере, следует, что используемые критерии отбора p-ν – событий являются надежными.

Предлагается метод для анализа асимметрии разлета заряженных частиц в СЦМ, с помощью которого исследуется роль флуктуаций при возникновении асимметричных ливней.

II-28

INVESTIGATION OF p–N INTERACTIONS ANGULAR CHARACTERISTICS AT 20 GeV

E.G.Boos, N.P.Pavlova, Zh.S.Takibayev, R.A.Tursunov

Institute of Nuclear Physics, Academy of Sciences, Kazakh.SSR

1035 proton interactions of free and quasi-free nucleons were selected in emulsion. From the comparison of particle number distributions of p-p interaction with the corresponding data obtained in the bubble chamber it results that the used selection criteria of p–N events are reliable.

A method for analyzing the asymmetry of charged particle distribution in the c.m.s. is proposed by which the fluctuation role is investigated when asymmetrical showers appear.

П-29

АНТИПРОТОН-НЕЙТРОННЫЕ ВЗАИМОДЕЙСТВИЯ ПРИ ИМПУЛЬСЕ 3 Бэв/с

В.А.Ботвин, Ж.С. Такибаев,
К.В. Шарапов.

Институт ядерной физики АН Казахской ССР

В стопке ядерных эмульсий, облученной пучком антипротонов с импульсом 3 Бэв/с, были выделены для анализа случаи неупругого взаимодействия антипротонов с квазисвободными нейтронами. Впервые для $\bar{p}n$ взаимодействий получены результаты, относящиеся к множественности генерированных пионов, их угловые и энергетические характеристики. Проведено сравнение с соответствующими данными для $\bar{p}p$ -взаимодействий в рассматриваемой области энергий.

ANTIPROTON-NEUTRON INTERACTIONS AT 3 GEV/c

V.A.Botvin, Zh.S.Takibayev, K.V.Sharapov

Institute of Nuclear Physics, Academy of Sciences
Kazakh SSR

In nuclear emulsion stack exposed to an antiproton beam at 3 GeV/c the events of antiproton inelastic interactions with quasi-free neutrons were separated for an analysis. The results of $\bar{p}$ n interactions related to generated pion multiplicity, their angular and energy characteristics, were obtained for the first time. The $\bar{p}p$ - interactions are compared to the corresponding data in the considered energy region.

ELASTIC SCATTERING, CHARGE EXCHANGE AND TWO-MESON ANNIHILATIONS OF 4.0 GeV/c ANTIPROTONS IN HYDROGEN

O.Czyzewski[*], B.Escoubès[o], Y.Goldschnidt-Clermont, M.Guinea-Moorhead, T.Hofmokl[+], P.R.O.Morrison and S. de Unamuno[x]

CERN, Geneva

Results on the measurement of 3200 two-prong events produced by 4.0GeV/c antiprotons in the Saclay 81 cm hydrogen bubble chamber will be presented. The elastic scattering differential cross section is shown to differ from that of protons and evidence dence for the enlarging of the diffraction peak with increasing energy will be given. Annihilations into two charged mesons only have been studied and the results are compared with statistical model calculations of Fast and Hagedorn. From measurements of anti-neutron stars, the differential cross section for charge exchange is shown to have a wider diffraction peak than that for elastic scattering.

---

[*] On leave from Institute for Nuclear Research, Cracow

[o] On leave from Faculté des Sciences, Paris (Orsay)

[+] Now at University of Warsaw

[x] CERN Fellow, on leave from Junta de Energia Nuclear, Madrid

π^-p INTERACTIONS AT 3.9 BeV/c

Robert W.Birge, Robert P.Ely, Jr., and Thomas Schumann

Lawrence Radiation Laboratory
University of California
Berkeley, California, USA

and

Zaven G.T.Guiragossian and Marian N.Whitehead

Stanford Linear Accelerator Center
Stanford University, Palo Alto
California

We have measured a sample of 24 000 π^-p interactions at 3.9 BeV/c in the Berkeley 72-inch hydrogen bubble chamber, with the F.S.D. measuring machine. We are studying two-prong four-prong, and neutrals accompanying two-prong interactions and will report on the results.

Antiproton-Proton Elastic Interactions and Cross Sections at 7 Bev/c*

T. Ferbel, A. Firestone, J. Johnson, H. Kraybill, J. Sandweiss† and H. Taft
Yale University
(to be presented by H.D.Taft)

Charged pronged interactions arising from a recent exposure of the new 80 inch BNL hydrogen bubble chamber to a separated beam[1] of 7 Bev/c antiprotons are being analyzed. Preliminary results indicate that the elastic scattering angular distribution is consistent with pure diffraction scattering for angles up to $\sim 20^{\circ}$ in the C.M. system. A discussion of Optical model fits to the elastic angular distribution, as well as comparisons of partial cross sections and elastic interactions with results obtained at lower momenta[2] will be presented.

* Work performed under the auspices of the U.S. Atomic Energy Commission.

† Alfred P. Sloan Foundation Fellow

1. I. Skillicorn and M.S. Webster; Status Report on High Energy Separated Beam for the 80 inch Chamber. BNL Internal Report H-10.
2. C. Baltay, et. al., "Interactions of High Energy Antiprotons in Hydrogen", Stanford Nuclear Structure Meeting (1963).

SEARCH FOR FRACTIONALLY CHARGED PARTICLES PRODUCED BY 27.5 GEV/c PROTONS

W.Blum*, S.Brandt, V.T.Cocconi, O.Czyzewski**, J.Danysz**, M.Jobes***, G.Kellner+, D.Miller++, D.R.O.Morrison, W.Neale++ and J.Rushbrooke+++

C.E.R.N., Geneva

An experiment has been performed to search for fractionally charged particles produced by the interactions of 27.5 GeV/c protons on a copper target in the CERN proton synchrotron, the existence of particles called "quarks" or "aces" of charge $\pm$ 1/3 and $\pm$ 2/3 of that of the electron having been suggested by M.Gell-Mann[1] and by G.Zweig[2]. Negative particles of apparent momentum of 20 GeV/c were selected and passed through the Saclay 81 cm hydrogen bubble chamber. For each of the 14 000 pictures taken, a photograph was taken of oscilloscope traces displaying the time relationship of the bubble chamber pressure curve and of the individual counter pulses caused by the particles entering the chamber. The bubble chamber photographs were scanned for tracks with abnormally low bubble density and the scope photographs for "early" pulses, i.e. for particles which hit the target before the main beam was deflected on to it and therefore entered the chamber before it was fully sensitive. The comparison of the two scans revealed that all the 15 tracks observed with subnormal bubble density corresponded to early pulses on the scope record. Therefore, no particle with charge between 0.3 and 0.7 e was found. This corresponds to an upper limit of about 10^{-36} cm^2 for the production cross section of particles with mass smaller than 2.6 GeV.

---

* On leave from the Max-Planck Institute, Munich

** Ford Foundation Fellow from University of Krakow

*** On leave from the University of Birmingham

\+ CERN Fellow from the Institute of Theoretical Physics, Vienna

++ On leave from Imperial College, London

+++ On leave from Oxford University

II-34

ОЦЕНКА СЕЧЕНИЯ РЕАКЦИИ $\pi^- + p \to \pi^0 + n$ ПРИ ИМПУЛЬСЕ 4.0 Гэв/с

М.А.Азимов, В.С. Пантуев, Л.В. Сильвестров,
М.Н. Хачатурян, И.В. Чувило

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Дана оценка сечения процесса

$$\pi^- + p \to \pi^0 + n$$

при импульсе 4 Гэв/с, полученная с помощью черенковского гамма-спектрометра из свинцового стекла. Для верхней границы сечения получена величина $\sigma \leq 0{,}16 \pm 0{,}02$ мб.

EVALUATION OF THE CROSS SECTION OF THE REACTION $\pi^- p \to \pi^0 n$ WITH THE MOMENTUM 4.0 GeV/c

M.A.Azimov, I.V.Chuvilo, M.N.Khachaturyan,
V.S.Pantuev, L.V.Silvestrov

Joint Institute for Nuclear Research
Laboratory of High Energies
Dubna, USSR

The value of the cross section of the process $\pi^- + p \to \pi^0 + n$ with the momentum 4 GeV/c is obtained with a Cerenkov gamma spectrometer of lead glass. The upper estimate of the cross section is found to be $\sigma \leq 0.16 \pm 0.02$ mb.

О МНОЖЕСТВЕННОСТИ π^0 МЕЗОНОВ В РЕАКЦИИ $\pi^- + p \to \pi^- + p + n\,\pi^0$ ПРИ 7-8 Гэв

Х.Хулубей, К.Бешлиу, А.Константинеску
Университет, Бухарест
А.Михул, В.Балинт, Д.Мумуиану, Т.Понта
Институт атомной физики, Бухарест

Проводилась оценка среднего числа π^0 мезонов, образованных в реакции: $\pi^- + p \to \pi^- + p + n\pi^0 \qquad n \geq 1.$

Реакции такого типа выбирались на снимках от 24-литровой пропановой пузырьковой камере ОИЯИ, облученной в пучке π^- при $(7{,}3 \pm 0{,}6)$ Гэв/с.

Были отобраны только случаи, для которых положительный след был идентифицирован как протон с передачей импульса

$$150 \text{ Мэв/с} \leq \Delta \leq 700 \text{ Мэв/с}.$$

Среднее число π^0 мезонов в реакции оценилось с помощью кинематических анализов и употребления коррелированных $e^+ e^-$ пар.

Экспериментальные данные были сравнены с результатами теоретических расчетов.

ON THE NEUTRAL PION MULTIPLICITY IN REACTION $\pi^- + p \rightarrow \pi^- + p + n\pi^0$ AT (7-8) GEV

H.Hulubei, C.Besliu, A.Constantinescu
Bucharest State University
and
A.Mihul, V.Balint, D.Mumulanu, T.Ponta
Institute for Atomic Physics, Bucharest
Rumania

An estimation was performed of the average number of π^0-mesons produced in reaction:

$$\pi^- + p \rightarrow \pi^- + p + n\pi^0 \qquad n \geq 1$$

Reactions of this type were selected in photographs from the 24 l propane bubble - chamber (Dubna) exposed to π^- with $P_{\pi^-} = (7.3 \pm 0.6)$ GeV/c.

Only those events were selected in which the positive secondary track was identified as that of the proton with the momentum transfer 150 MeV/c $\leq \Delta \leq$ 700 MeV/c.

The average number of π^0 per reaction was evaluated by kinematical analyses and by using the observed e^+e^- pairs correlated with our events.

These experimental results were compared with theoretical computations.

П-36

ПОЛЯРИЗАЦИЯ В Р-Р РАССЕЯНИИ ПРИ ЭНЕРГИИ ПРОТОНОВ 4,8 БЭВ И ПОВЕДЕНИЕ АМПЛИТУДЫ С "ПЕРЕВОРОТОМ СПИНА" ПРИ БОЛЬШИХ ЭНЕРГИЯХ

В.П.Канавец, И.И. Левинтов, Б.В.Морозов

Институт теоретической и экспериментальной физики

Москва, СССР

Представлены новые данные о поляризации протонов отдачи в Р-Р рассеянии, полученные на синхрофазотроне ОИЯИ.

Рассматриваются ограниченая на поведение амплитуды с "переворотом спина" при высоких энергиях, вытекающие из результатов опытов по поляризации и диффракционному рассеянию.

POLARIZATION IN p-p SCATTERING AT THE PROTON ENERGY 4.8 BeV AND THE BEHAVIOUR OF THE SPIN-FLIP AMPLITUDE AT HIGH ENERGIES

V.P.Kanavets, I.I.Levintov, B.V.Morosov
Institute for Theoretical and Experimental Physics,
Moscow, USSR

New data on the polarization of recoil protons in p-p scattering obtained on the synchrophasotron of UJNR are presented.

The restrictions on the behaviour of the spin-flip amplitude following the results of polarization and diffraction scattering are considered.

П-37

ИССЛЕДОВАНИЕ НЕУПРУГИХ ВЗАИМОДЕЙСТВИЙ Π^--МЕЗОНОВ С ПРОТОНАМИ И НЕЙТРОНАМИ ПРИ $\sim$ 4 БЭВ/С

Б.А. Шахбазян

Объединенный институт ядерных исследований

Лаборатория высоких энергий

Дубна

Исследуются неупругие взаимодействия Π^- мезонов с импульсом 4 Бэв/с с протонами и нейтронами с помощью ядерных эмульсий, помещенных в магнитное поле 50 кгс.

Метод позволяет идентифицировать Π^-, Π^+ - мезоны и протоны. Проводится сравнение взаимодействий Π^--р и Π^-- n. Результаты сопоставляются с теоретическими моделями взаимодействий П-нуклон, а также с $\pi^- p$ - взаимодействиями в водородной камере.

AN INVESTIGATION OF INELASTIC INTERACTIONS OF π^- MESONS WITH PROTONS AND NEUTRONS AT ~ 4BEV/c MOMENTUM

B.A.Shahbazian
Joint Institute for Nuclear Research
Dubna, USSR

The inelastic interactions of negative π^--mesons with protons and neutrons at ~ 4 Gev/c momentum are investigated by means of emulsions placed in a magnetic field of 50000 Gauss.

The method used permits to identify π^-, π^+-mesons and protons. A comparison is made between the π^--proton and π^--neutron interactions. The results are compared with the theoretical models of π- meson-nucleon interaction as well as with the data on $\bar{p}p$ collisions, produced in hydrogen bubble chambers.

П-38

ИЗУЧЕНИЕ РЕАКЦИЙ С ОБРАЗОВАНИЕМ 3-х ЗАРЯЖЕННЫХ ЧАСТИЦ В $n-p$ ВЗАИМОДЕЙСТВИЯХ

Вишневский Б.Ф., Ду Юань-цай, Мороз В.И., Никитин А.В., Троян Ю.А., Цзян Шао-цзюн, Чжан Вэнь-юй, Шахбазян Б.А., Янь У-гуан.

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

24-литровая пузырьковая пропановая камера облучалась пучком нейтронов из синхрофазотрона ОИЯИ, выходящих под углом 0^{o} к траектории протонов в ускорителе в месте расположения мишени. В качестве мишени использовался брусок из Be размерами 5x5x2 $см^{3}$.

Отбирались звезды с тремя заряженными лучами. Анализ по суммарному поперечному импульсу даёт возможность выделить из всех звезд реакцию $np \to pp\pi^{-}$.

Используя расчетный ход сечения такой реакции по статистической теории, известные экспериментальные значения полного сечения np - взаимодействий и энергетическое распределение звезд от реакции $np \to pp\pi^{-}$, можно получить спектр нейтронов. Спектр имеет треугольную форму с максимумом при энергии 8 Гэв. Для получения истинного спектра нейтронов из мишени необходимо ввести поправки на поглощение в веществе, находившемся на пути пучка.

STUDY OF THE REACTIONS CONCERNING THE FORMATION OF 3-PRONG STARS IN N-P - INTERACTION

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A., Chiang Shao-chun, Chang W.Y., Shahbazian B.A., Yen Wu-kuang

A 24 litre propane bubble chamber was irradiated with a neutron beam generated from the 10 GeV proton synchrotron, which came out at 0°, at the target, with the proton track in the accelerator. The target consisted of a Be block having dimensions of 5 x 5 x 2 cm.

For studying the neutron spectrum, three-prong stars without V^0 have been selected. The analysis based on the method of balancing transverse momenta gives a possibility of separating $np \longrightarrow pp\pi^-$ from all the stars examined. Making use of the calculated cross-section of the above reaction by a statistical theory, the known experimental value for the total n-p interaction and of the energy distribution of the 3-prong stars $np \longrightarrow pp\pi^-$, we have obtained a neutron spectrum. The spectrum has a nearly triangular form having a maximum at about 8 GeV. To obtain the true spectrum of the neutrons from the target, it is necessary to correct for the absorption in the materials found on the way of the beam.

КВАЗИУПРУГИЕ $\pi^- N$- ВЗАИМОДЕЙСТВИЯ ПРИ ЭНЕРГИИ 9 ГЭВ.

И.М.Граменицкий, Т.Канарек, В.М. Мальцев,
А. Прокеш, Л.А. Тихонова

Объединенный институт ядерных исследований

Лаборатория высоких энергий

Дубна

Исследовались квазиупругие взаимодействия Π^--мезонов с импульсом 9 Гэв/с на связанных нуклонах в ядре ксенона (Z =54, A =I3I):

(I) $\pi^- + p \rightarrow \pi^- + p$

(2) $\pi^- + n \rightarrow \pi^- + n$

Преимущество ксеноновой пузырьковой камеры - большая эффективность регистрации γ - квантов ($\sim$90%) - дала возможность надежно отделить взаимодействия (I) и (2) от фоновых взаимодействий типа

(3) $\pi^- + N \rightarrow \pi^- + N + m\pi^0, \quad m = 1, 2, \ldots$

Реакция (I) использовалась для определения эффективного числа протонов в ядре ксенона, ответственных за квазиупругие взаимодействия, т.е. для определения "коэффициента экранирования" $\eta = \frac{\sigma_{квазиупр.}(\pi^- p)}{Z \cdot \sigma_{упр.}(\pi^- p)}$

Для оценки коэффициента экранирования проводился расчет методом Монте-Карло квазиупругих $\pi^- N$- взаимодействий, происходящих на связанных нуклонах в ядре ксенона. Полученные расчетные данные сравнивались с экспериментальными данными. Предполагая, что коэффициент экранирования для нейтронов такой же, как для протонов, было определено сечение упругого рассеяния Π^- мезонов на квазисвободных нейтронах и сравнено с упругим $\pi^+ p$ рассеянием при 8,9 Гэв/с.

QUASI-ELASTIC π^--N-INTERACTIONS AT ENERGY OF 9 GEV

I.M.Gramenitskij, T.Kanarek, V.M.Maltsev,
A.Prokeš, L.A.Tichonova

Joint Institute for Nuclear Research
Dubna, USSR

A study was made of the following quasi-elastic interactions of 9 GeV/c π^--mesons with nucleons bound in Xe - nuclei

(1) $\pi^- + p \longrightarrow \pi^- + p$

(2) $\pi^- + n \longrightarrow \pi^- + n$

The special feature on the Xe-bubble chamber is the high efficiency of γ-quanta detection ($\sim 90\%$). This gives the possibility of reliable separation between (1) and (2) interactions and the background events such as :

(3) $\pi^- + N \longrightarrow \pi^- + N + m\pi^0$, $\quad m = 1,2,\ldots$

Reaction (1) was used to determine the effective number of protons in Xe-nuclei responsible for quasi-elastic interactions, e.g. for the determination of the "screening coefficient"

$$\eta = \frac{\sigma_{qel}(\pi^- p)}{z\,\sigma_{el}(\pi^- p)}$$

To determine the "screening coefficient" the calculation of quasi-elastic (π^- N) interactions with the bound nucleus in Xe-nuclei was carried out by the Monte-Carlo method.

Calculation data have been compared with experimental results.

Assuming that the "screening coefficient" is the same for neutrons and for protons the elastic scattering cross-section for π^--mesons on quasi-free neutrons was defined and compared with elastic π^+-p scattering at 8.9 GeV/c.

П-40

ИЗУЧЕНИЕ КВАЗИНУКЛОННЫХ ВЗАИМОДЕЙСТВИЙ В ФОТОЭМУЛЬСИИ ДЛЯ ПРОТОНОВ С ЭНЕРГИЕЙ $E_0 \sim 20$ Бэв.

Г.Б. Жданов, М.И.Третьякова, М.М.Чернявский, М.Н. Щербакова

Физический институт им. П.Н. Лебедева,

Москва, СССР.

В обычных фотоэмульсиях измерены угловые распределения для 400 звезд с $N_s \leqslant 1$ и $N_g \leqslant 1$. Для них же получены импульсные и угловые распределения 300 идентифицированных частиц. Определена средняя масса мишени ($I,2\, M_N$) для звезд с $N_s \leqslant 1$ и $N_g \leqslant$ I и рассмотрены методы выделения звезд со средней массой мишени, близкой к массе нуклона M_N.

В фотоэмульсиях с магнитным полем измерены углы, импульсы и знаки заряда для I00 частиц из звезд того же типа (E_0 =23 Бэв).

Полученные распределения π -мезонов и протонов по углам и импульсам в с.ц.и. нуклон-нуклон, распределения 4-мерных импульсов Δ^2 и коэффициентов неупругости для протонов сравниваются с соответствующими литературными данными для нуклон-нуклонных взаимодействий при ускорительных энергиях и взаимодействиями на $Li\ H$ при энергиях $I0^{II}$ - $I0^{I2}$ эв, а также с расчетами по модели одномезонного обмена и статистической теорией. В распределении по Δ^2 наблюдается один максимум в области больших значений Δ^2 при среднем значении $\overline{\Delta^2} \approx 1,0$ (Бэв/с)^2. Сопоставлены распределения протонов по величинам $p_\perp$ и $\Delta p_\parallel$ (поперечный импульс и изменение продольного). Рассмотрены некоторые способы выделения непериферических взаимодействий.

Оценивается относительная доля K- мезонов в различных энергетических интервалах.

INVESTIGATION OF QUASINUCLEON INTERACTIONS IN PHOTOEMULSION FOR 20 GEV PROTONS

G.B.Zhdanov, M.I.Tretyakova, M.M.Chernyavsky,
M.N.Schcherbakova
P.N.Lebedev Institute of Physics, Moscow, USSR

The nagular distributions for 400 stars of thetype $N_b \leq 1$ и $N_g \leq 1$ have been measured by a conventional emulsion method. The momentum and angular distributions for 300 identified particles have been also obtained. The mean target mass ($M \approx 1{,}2\ M_N$) for these stars is determined and the methods of selection with $M \sim M_N$ are discussed.

The emission angles, momenta and charges for 100 particles in the similar stars (E = 23 GeV) have been measured by emulsions which were exposed in pulsed magnetic field.

The angular and momentum C.M. distributions of pions and protons and also the 4 - momenta Δ^2 and inelasticity distributions for protons are compared with corresponding published data for NN-interactions at accelerator energies. and interactions in LiH at 10^{11} - 10^{12} eV as well as with one meson exchange model and statistical theory calculations.

In the Δ^2-distribution a maximum at $\overline{\Delta^2} \approx 1\ (\mathrm{GeV/c})^2$ is displayed. The P_t - and $\Delta P_{\parallel}$ - distributions of protons (transversal momentum and change of longitudinal momentum are compared.

Some possible procedures of nonperipherical collision selection are considered.

The relative share of K-mesons in the different energy intervals is estimated.

П-4I

ОБРАЗОВАНИЕ НЕЙТРАЛЬНЫХ МЕЗОНОВ ВО ВЗАИМОДЕЙСТВИЯХ π^- МЕЗОНОВ С ИМПУЛЬСОМ 9 ГЭВ/С С ЯДРАМИ Xe

К.Эскрайс, Е.Лоскевич, Я.Заорска

Институт ядерных исследований, Лаборатория высоких энергий
Краков, Польша.

Измерены энергии и углы вылета электронно-позитронных пар в ~ 800 столкновениях π^- мезонов с ядрами ксенона и в ~250 столкновениях π^- мезонов с квазисвободными нуклонами ядра. Измерения проводились на пленках, полученных в ксеноновой камере ОИЯИ.

Энергетический спектр γ - квантов имеет типичный максимум при 70 Мэв, соответствующий распаду $\pi^0 \to \gamma + \gamma$. Возможность генерации η^0 мезонов исследовалась в столкновениях с большой кратностью γ квантов с помощью распределения инвариантных масс $M_{\gamma\gamma}$.

Будет представлен энергетический спектр π^0 мезонов и сравнение столкновений π^- - ядра и π^- - нуклона .

ON THE NEUTRAL MESON PRODUCTION IN THE COLLISIONS OF π^- MESONS WITH Xe NUCLEI AT 9 GEV/c

K.Eskreys, J.Loskiewicz, J.Zaorska
Institute of Nuclear Research, Laboratory of High Energy Physics, Krakow, Poland

In $\sim$ 800 interactions of the type π^- + Xe and ~250 of the type π^- + N (quasi-free nucleons) observed in a Xe bubble chamber (Dubna), the energies and the angles of emission of the electron pairs were measured. The γ - ray energy spectrum shows the typical peak corresponding to the $\pi^0 \to \gamma + \gamma$ decay. The possibility of η^0 production in stars with a large number of photons is investigated on the basis of the distribution of the invariant $M_{\gamma\gamma}$-mass. The π^0 meson energy spectrum as well as a comparison between π^-- nucleus and π^--nucleon collisions will be presented.

П-42

ВЗАИМОДЕЙСТВИЯ π^- МЕЗОНОВ С ИМПУЛЬСОМ 10 GeV В ВОДОРОДЕ С САМОЙ БОЛЬШОЙ МНОЖЕСТВЕННОСТЬЮ ЗАРЯЖЕННЫХ ЧАСТИЦ

Е.Бартке, А.Эскрайс, Г.Пыткович

Институт ядерных исследований, Лаборатория высоких энергий

Краков, Польша

К. Залевски

Ягеллонский Университет, Краков, Польша

М. Бардадин

Университет, Варшава, Польша

Л.Михейда, С.Отвиновски, Р.Сосновски

Институт ядерных исследований, Лаборатория высоких энергий,

Варшава, Польша

Проанализированы 132 восьми-и десяти - лучевые звезды, вызванные в 80 см водородной пузырьковой камере пучком π^- - мезонов с импульсом 10 GeV от синхротрона в ЦЕРНе. Эти звезды составляют два процента от всех неупругих соударений и обладают самой большой множественностью, наблюдаемой при данной энергии первичных π^- -мезонов.

Передача импульса бариону оказывается часто довольно большая. Угловые распределения отрицательных и положительных π-мезонов не отличаются сильно друг от друга и они легко анизотропны. Среднее количество π^0- мезонов малое.

Делается попытка разделить сечение реакции на центральную и периферическую части.

INTERACTIONS OF 10 GeV/c π^- IN HYDROGEN WITH THE HIGHEST MULTIPLICITY OF CHARGED PARTICLES

J.Bartke, A.Eskreys, G.Pytkowicz
Institute of Nuclear Research, Laboratory of High Energy Physics, Krakow, Poland

K.Zalewski
Jagiellonian University, Krakow, Poland

M.Bardadin
University of Warsaw, Poland

L.Michejda, S.Otwinowski, R.Sosnowski
Institute of Nuclear Research, Laboratory of High Energy Physics Warszawa, Poland

A sample of 132 eight- and ten-prong stars produced by 10 GeV/c negative pions from the CERN P.S. in the 80 cm hydrogen bubble chamber has been investigated. These events constitute about 2% of all inelastic events and represent the highest multiplicity observed at this energy of primary pions.

It is shown that the momentum transfer to the baryon is often very high. The angular distributions of negative and positive pions do not differ much and both are only slightly anisotropic. The average number of neutral pions is low.

An attempt is made to split the cross-section into central and peripheral parts.

POLARIZATION IN p-p SCATTERING FROM 1.7 GeV TO 6.2 GeV*

H. Steiner, F. Betz, O. Chamberlain,
B. Dieterle, P. Grannis, C. Schultz,
G. Shapiro, L. Van Rossum, and D. Weldon

University of California
Lawrence Radiation Laboratory
Berkeley, California

Using a polarized proton target, we have measured the polarization in p-p scattering at beam energies of 1.7, 2.85, 4.0, 5.1, and 6.2 Gev for momentum transfer in the range of 350 to 1100 MeV/c.

Quasielastic events arising from scattering on heavy nuclei in the target and other background were kinematically separated from elastic events by counting both protons in coincidence. The background counting rate was measured continuously and could be accurately subtracted from the data. At all energies considered the polarization shows a broad maximum for momentum transfer between 400 and 800 MeV/c. The maximum polarization shows a smooth decrease as the energy is increased.

*Work sponsored by the U. S. Atomic Energy Commission.

THE REACTION $n + n \rightarrow n + p + \pi^-$ AT 1.8 BeV/c

Robert W.Birge, Robert P.Ely, Jr.George Gidal, George E.Kalmus, Anne Kernan and Sedong Kim

Lawrence Radiation Laboratory, University of California
Berkeley California

We have studied the reaction $n + n \rightarrow n + p + \pi^-$ in the 20-inch Brookhaven deuterium bubble chamber, using a 3.69 BeV/c separated deuteron beam from the AGS. The events are selected from the reactions $d + d \rightarrow p + p + p + \pi^- + n$, in which two protons are spectators. The n-n reaction is characterized by N^{*-} 3/2, 3/2 formation. We have tested our data against the single-pion-exchange model. The results are compared with those from the charge symmetric reaction, $p + p \rightarrow n + p + \pi^+$ which is characterized by N^{*++} formation. The $N^{*-} - N^{*++}$ mass difference is related to the mass splitting within the $Y^*_{1,\ 3/2}$ multiplet by the SU3 symmetry scheme.

Multiple Pion Production (Without Annihilation) in $\bar{p}$ - p Collisions at 7 Bev/c*

T. Ferbel, H. Kraybill, J. Johnson, J. Sandweiss† and H. Taft, Yale University

An analysis of multiple pion production (without annihilation) in $\bar{p}$-p collisions is in progress. The production of the T = 1/2 and the T = 3/2 pion-nucleon isobars is studied as a function of the bombarding energy. The data at the highest energy were obtained in an exposure of the BNL 80 inch bubble chamber to a 7 Bev/c separated antiproton beam.[1] A quantitative comparison of our data at 7 Bev/c as well as 3-4 Bev/c[2] with the predictions of various one-particle exchange models[3] will be presented.

1. I. Skillicorn and M. S. Webster; Status Report on High Energy Separated Beam for the 80 inch Chamber. BNL Internal Report H-10.
2. T. Ferbel, et. al., Phys. Rev. Letters 9, 351 (1962).
3. E. Ferrari and F. Selleri, Nuovo Cimento 24, 453 (1962)
   L. Durand, and Y. T. Chiu, Phys. Rev. Letters 12, 399 (1964).

ELASTIC SCATTERING AND SINGLE PION PRODUCTION IN PP INTERACTION AT 4 BEV/c

J.Kidd, L.Mandelli, V.Pelosi, S.Ratti and L.Tallone
Istituto di Fisica and Sezione INFN - Milano

M.Dameri, C.Grosso and G.Tomasini
Istituto di Fisica and Sezione INFN - Genova

In 40 000 pictures taken with the 81 cm. Saclay H.B.C., exposed to a beam of 4 BeV/c protons at the CERN PS, about 3000 2 prong events have been fully analyzed.

About 1400 of them are pp elastic scattering and correspond to a cross section of about 14 mb for events with $t \leq -0.02$ $(BeV/c)^2$.

Comparison has been made with the prediction of the Optical Model and an estimate of about 1 fermi for the radius has been obtained, to be compared with 1.5 f for $\bar{p}$ of corresponding energy.

The inelastic channels have been analyzed in terms of isobar production, within the framework of the O.P.E. model.

All possible resonant states will be investigated.

MULTIPLE PION PRODUCTION IN PROTON PROTON COLLISION AT 4 BEV/c

J.kidd, L.Mandelli, V.Pelosi, S.Ratti and L.Tallone
Istituto di Fisica and Sezione INFN - Milano

F.Conte and G.Tomasini
Istituto di Fisica and Sezione INFN - Genova

The following interactions have been studied in 40 000 pictures taken in the 81 cm. Saclay H.B.C. exposed to a proton beam of 4 BeV/c at the CERN PS:

$p+p \rightarrow p + p + \pi^+ + \pi^-$

$p+p \rightarrow p + p + \pi^+ + \pi^- + \pi^0$

$p+p \rightarrow p + n + \pi^+ + \pi^+ + \pi^-$

Production of the omega particle is observed with a cross section of about 0.14 mb.

Abundant production of (πN) isobars is also observed.

All other significant deviations from phase space seem to be explainable by the presence of the (3,3) resonance.

To data about 1600 4 prong events have been measured and partially analyzed. The cross section for isobar production will be presented and the production mechanism will be analyzed with about 2000 events.

PROTON - ANTIPROTON INTERACTIONS AT 5.7 GeV/c

K. Böckmann, B. Nellen, E. Paul
Physikalisches Institut der Universität Bonn, Bonn, Germany

I. Borecka, E. Lohrmann
Deutsches Elektronen Synchrotron DESY, Hamburg

J. Diaz, U. Heeren, U. Liebermeister, E. Raubold
P. Söding, S. Wolff
II. Institut für Experimentalphysik der Universität Hamburg, Hamburg

S. Coletti, J. Kidd, L. Mandelli, C. Telosi, S. Ratti, L. Tallone
Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Milano / Italy

Proton-Antiproton interactions were studies in the 81 cm Saclay HBC, exposed to a beam of 5.7 GeV/c antiprotons at CERN. Results on pion production without annihilation will be given and compared with the peripheral model and with experimental results at 3.6 GeV/c

ELASTIC SCATTERING, CHARGE EXCHANGE AND TWO-MESON ANNIHILATIONS OF 4.0 GeV/c ANTIPROTONS IN HYDROGEN

O. Czyzewski*, B. Escoubès°, Y. Goldschmidt-Clermont, M. Guinea-Moorhead, T. Hofmokl+, D.R.O. Morrison, and S. de Unamuno¤

C.E.R.N., Geneva

Results on the measurement of 3200 two-prong events produced by 4.0 GeV/c antiprotons in the Saclay 81 cm hydrogen bubble chamber will be presented. The elastic scattering differential cross section is shown to differ from that of protons and evidence for the enlarging of the diffraction peak with increasing energy will be given. Annihilations into two charged mesons only have been studied and the results are compared with statistical model calculations of Fast and Hagedorn. From measurements of anti-neutron stars, the differential cross section for charge exchange is shown to have a wider diffraction peak than that for elastic scattering.

* On leave from Institute for Nuclear Research, Cracow

° On leave from Faculté des Sciences, Paris (Orsay)

+ Now at University of Warsaw

¤ CERN Fellow, on leave from Junta de Energia Nuclear, Madrid

TOTAL CROSS-SEVTIONS OF PROTONS, ANTI-PROTONS, Pi- AND K-MESONS ON HYDROGEN AND DEUTERIUM IN THE MOMENTUM RANGE 4-22GeV/c

W.Galbraith, E.W.Jenkins, T.F.Kycia
B.A.Leontic, R.H.Phillips, and A.L.Read

Brookhaven National Laboratory, Upton, N.Y., U S A

and

R.Rubinstein, Cornell University, Ithaca, N.Y., USA

Accurate measurements have been made at the Brookhaven AGS machine of the total cross-sections of p, $\bar{p}$, $\pi^{\pm}$ and $K^{\pm}$ on hydrogen and deuterium over a wide momentum range (4-22 GeV/c) covered at intervals of 2 GeV/c. The method adopted was that of a conventional good geometry transmission experiment with scintillation counters, subtending various solid angles at targets of liquid H_2 and D_2. Problems associated with attanding a high accuracy in the measurement of a total cross-section in such experiments are discussed. It was found that, with the increase in statistical accuracy of the data, a previously adopted procedure of lineary extrapolating to zero solid angle the partial cross-sections measured at finite solid angles was not a sufficiently accurate procedure from which to deduce σ_T. Knowledge of the angular distributions of elastic and inelastic processes near the forward direction of scattering is required to interpret the fitting of the experimental points to some form of a diffreaction pattern. The particle-neutron cross-sections are derived by applying the Glauber screening correction to the difference between the particle-deuteron and -proton cross-sections. The cross-sections $\sigma_T(\pi^+ d)$ and $\sigma_T(\pi^- d)$ are found to be equal at all momenta up to the highest measured (20 GeV/c) indicating the validity of the assumption of charge symmetry up to this momentum. Results are presented showing how the individual particle cross-sections vary with momentum; evidence is found for a small, but finite, continuous fall in σ_T(pp) (and σ_T(pn)) in the momentum region above 12 GeV/c.

DETAILED STUDY OF THE REACTION $p+p \rightarrow \pi^+ + d$

R.M.Heinz, L.W.Jones, M.J.Longo,
O.E.Overseth, D.E.Pellett
University of Michigan

F.Martin and M.L.Perl
Stanford University, USA

The differential cross section for the reaction $p+p \rightarrow \pi^+ + d$ has been measured to about 10% accuracy in intervals of 0.1 in $\cos\theta$ (center of mass) and at several energies in the range from 1.3 to 2.9 GeV incident proton kinetic energy in the external beam of the Cosmotron of the Brookhaven National Laboratory. The cross sections are characterized by a peak near 30° c.m. at the lower energies with a minimum in the forward direction. At higher energies the cross sections show no such peak but rather appear to extrapolate to a maximum near 0°. At all energies a broad minimum about 90° is seen, which falls to progressively lower values of cross section at higher energies. The data are compared to other differential and total cross sections published for this reaction as well as to the different theoretical models

ELASTIC AND TWO-PRONG INELASTIC INTERACTIONS OF 8 GEV/c π^+ IN HYDROGEN

Aachen - Berlin - CERN Collaboration

Results will be presented on the analysis of about 3000 two-prong interactions of 8 GeV/c positive pions in the Saclay 81cm hydrogen bubble chamber. The differential cross-section for small angle elastic scattering will be extrapolated to zero degrees to compare with the Optical Theorem Value. Production of resonances and of isobars will be discussed particularly in terms of peripheral mechanisms.

Deuteron Stripping at 3.54 GeV/c

Richard L. Lander, Oreste Piccioni,
Nguyen-huu Xuong, and P. Yager

This paper presents the angle and momentum distributions for protons stripped from deuterons at 3.54 GeV/c by aluminum, copper and lead. The parameters of interest are summarized in the Table. Roughly, the results are consistent with a cross section about $\frac{1}{2}$ geometric (where $r = 1.22A^{1/3} \times 10^{-13}$ cm) and a momentum distribution obtained by transforming the deuteron internal-momentum distribution to the laboratory frame. The expected angular spread (from the multiple scattering in the stripper, the internal momentum distribution of the deuteron, and the large-angle Coulomb scattering during the stripping collision) is compatible with the observed distributions.

d^+ momentum, GeV/c	3.54 ± 0.100	
p^+ momentum, GeV/c	1.77 ± 0.100	
FW $\frac{1}{2}$ max, angle spread	3°	
σ_s (Al)	290 mb	± 25%
σ_s (Cu)	550	
σ_s (Pb)	950	

IУ

ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (до I Гэв)

Теория

INTERACTIONS OF PIONS AND NUCLEONS (up to 1 GeV)

Theoretical

IУ-I

ОБ АНОМАЛЬНОЙ ОСОБЕННОСТИ И ОПРЕДЕЛЕНИИ АМПЛИТУД НЕКОТОРЫХ ПРОЦЕССОВ

Б.Н. Валуев

Объединенный институт ядерных исследований
Лаборатория теоретической физики

Показано, что условия аномальной особенности треугольной диаграммы в случае нестабильных частиц имеют простой кинематический смысл. Получено выражение для амплитуды треугольной диаграммы, из которого легко выделить часть, содержащую аномальную особенность. При определенных условиях особенность появляется в физической области изменения переменных, если ширина стремится к нулю. Экспериментальное исследование этой особенности в реакциях с образованием резонансов может позволить определить амплитуды таких процессов как $\pi\pi \to \pi\pi$, $\pi\Lambda \to \pi\Lambda$ и т.п. Кроме того, аномальная особенность может вести к появлению "горбов" в распределениях по эффективной массе, имитирующих слабые резонансы (например, горб в распределении по эффективной массе пар $K^0 K^+$ около I Бэв и так называемый АВС-резонанс, указывающий на возможность существования возбужденного ядра, у которого один из нуклонов замещен изобарой N^* - I238).

ANOMALOUS SINGULARITY AND DETERMINATION OF AMPLITUDES FOR SOME PROCESSES

B.N.Valuev

Joint Institute for Nuclear Research
Dubna

Anomalous singularity conditions are shown in the case of unstable particles to have a simple kinematical meaning. If the full width tends to zero and some other conditions hold anomalous singularity appears in the "physical" region.

Experimental investigation of this singularity in reactions with production of resonances may help to determine amplitudes of such processes as $\pi\pi \to \pi\pi$, $\pi\Lambda \to \pi\Lambda$, etc. Furthermore, anomalous singularity may manifest itself as "humps" in effective mass distributions thus imitating weak resonances. (For example, the hump in the effective mass distribution of $K_1^0 K_1^0$ pairs near 1 GeV and the so called ABC-resonance, which perhaps indicates on the existence of excited nuclei, in which a nucleon is replaced by the isobar $N^{\frac{3}{2}}$ 1238)

IУ-2

ВЛИЯНИЕ МЕЗОН-НУКЛОННЫХ РЕЗОНАНСОВ НА РЕАКЦИИ С УЧАСТИЕМ ЯДЕР

В.В. Анисович, В.М. Шехтер

Физико-технический институт им. А.Ф. Иоффе, Ленинград, СССР.

Изучаются свойства определенного класса диаграмм, включающих барион-мезонные изобары в промежуточном состоянии. При некоторых условиях вклад таких диаграмм в амплитуду разного рода реакций с участием ядер быстро меняется с изменением энергии, что приводит к появлению максимумов резонансного типа со специфическими свойствами. В частности если такая диаграмма с 3/2 изобарой доминирует в реакции $p+p \to d+\pi^+$ угловое распределение должно иметь вид $\sim (1+3\cos^2\theta)$. Вклад в такую реакцию от изобар с T=I/2 входит с весом в 2 раза меньшим, чем для изобар с T=3/2.

THE EFFECT OF MESON NUCLEON RESONANCE ON THE REACTIONS WITH THE PARTICIPATION OF NUCLEI

V.V.Anisovish and V.M.Shekhter

A.F.Ioffe Physical Technical Institute,
Leningrad, USSR

The properties of the definite class of diagrams including baryon-meson isobars in the intermediate state are investigated. Under certain conditions the contribution from such diagrams to the amplitudes of various reactions with the participation of nuclei changed very fast with the energy variation. This leads to the appearance of the resonance type maxima with the specific properties. In particular, if such a diagram with 3/2, 3/2 isobars predominates in the reaction $p+p \to d+\pi^+$, the angular distribution must be of the form $\sim(1 + 3\cos^2\theta)$. The contribution to this reaction from an isobar with T= 1/2 has the weight twice smaller than that from an isobar with T= 3/2 .

IУ-3

К ТЕОРИИ ВЗАИМОДЕЙСТВИЯ МЕДЛЕННЫХ ПРОТОНОВ С ДЕЙТРОНАМИ.

А.А. Ансельм, Г.С. Данилов

Физико-технический институт им. А.Ф. Иоффе
Ленинград, СССР

Рассмотрено взаимодействие медленных протонов (длина волны которых гораздо больше радиуса действия ядерных сил) с дейтронами. Задача сводится к одновременному учету ядерного и кулоновского взаимодействия протонов. Показано, что упругое рассеяние протонов дейтронами может быть описано формулами типа Ландау-Смородинского для p-p - рассеяния, либо (в другой области энергий) простой суммой ядерной и кулоновской амплитуд. Амплитуда реакции $p+d\to p+p+n$ может быть получена довольно простым образом из амплитуды реакции $n+d\to n+n+p$, если пренебречь кулоновскими поправками $\frac{e^2}{\hbar v_t}\sim 0{,}1$ / v_t - "триплетная" скорость нуклонов в дейтроне) и считать, что полная энергия трех образующихся частиц гораздо больше абсолютной величины виртуальной синелетной энергии связи нуклонов.

THE INTERACTION OF SLOW PROTONS WITH DEUTRONS

A.A.Anselm, G.S.Danilov

A.F.Ioffe Physical Technical Institute
Leningrad, USSR

The interaction of slow protons with deuterons is considered when the wave length of incoming protons is much greater than the radius of nuclear forces. It is necessary in that case to take into account both electromagnetic and nuclear interactions of protons. It is shown that the elastic p-d scattering can be described by the formulas which is similar to Landau- Smorodinsky's formulas for p-p scattering or (in an other energy region) the p-d scattering amplitude is equal to the simple sum of the nuclear and colomb amplitudes. The amplitude of the reaction $p+d \longrightarrow p+p+n$ can be constructed by a rather simple way from the $n+d \longrightarrow n+n+p$ amplitude, if we neglect such a terms which is of order of $\sim \frac{\theta^2}{\hbar v_t} \sim 0.1$ ("v_t" is the "triplet velocity" of the nucleus in the deutron) and consider the case, when the energy of the final particles is much greater than the singlet bound energy of nucleons.

ЛОГАРИФМИЧЕСКИЕ СИНГУЛЯРНОСТИ В РЕАКЦИЯХ $\pi^- + p \to n + \pi^+ + \pi^-$ И $p + d \to He_3 + 2\pi$

В.В.Анисович, Л.Г.Дахно

Физико-технический институт им. А.Ф. Иоффе
Ленинград, СССР

В амплитуде реакции $\pi + N \to N + \pi + \pi$ имеется логарифмическая особенность, которая возникает от диаграмм, описывающих рождение двух π - мезонов через изобару (3.3) с последующим рассеянием образовавшихся π -мезонов. Эта логарифмическая особенность при энергиях падающего мезона в лабораторной системе порядка 300-600 Мэв подходит близко к физической области реакции и может оказывать сильное влияние на энергетическое распределение по массе двух π -мезонов вблизи $M_{\pi\pi} \sim 2$. В зависимости от знака остальных членов амплитуды наличие этой логарифмической особенности может либо сильно понижать вероятность рождения двух π -мезонов при $M_{\pi\pi} \sim 2$, либо сильно повышать её.

Эффект понижения вероятности рождения π -мезонов при $M_{\pi\pi} \sim 2$ наблюдается в реакции $\pi^- + p \to n + \pi^+ + \pi^-$ при $E_\pi \sim 300 - 600$ Мэв. При $E_\pi \sim 700$ Мэв эта логарифмическая особенность удаляется от физической области реакции и перестаёт влиять на спектр π - мезонов. Последний эффект также наблюдается экспериментально в реакции $\pi^- + p \to n + \pi^+ + \pi^-$.

Аналогичным образом можно объяснить экспериментальные данные по реакции $p + d \to He_3 + 2\pi$. Предполагается, что этот процесс может происходить через рождение "изобары" He_3 с последующим рассеянием π-мезонов друг на друге. Эксперименты проводились Абашьяном, Бутом и Кроу при $E_p \sim 600$-700 Мэв. При таких энергиях логарифмическая особенность подходит близко к физической области реакции и может приводить к резкому повышению вероятности рождения π -мезонов при $M_{\pi\pi} \sim 2$. В этой реакции логарифмическая особенность должна отойти от физической области при $E_p \gtrsim$ 1300 Мэв, и при таких энергиях максимум в спектре π - мезонов при $M_{\pi\pi} \sim 2$ уже не должен наблюдаться.

LOGARITHMIC SINGULARITIES IN PROCESSES $\pi^- + p \to n + \pi^+ + \pi^-$ AND $p + d \to He_3 + 2\pi$

V.V.Anisovish, L.G.Dakhno

A.F.Ioffe Physical Technical Institute, Leningrad, USSR

The amplitude of the reaction $\pi + N \to N + \pi + \pi$ has the logarithmic singularity that appears from the graphs which describe two pion production through isobar (3.3) and the following scattering of the produced pions. At pion laboratory energy 300-600 MeV this logarithmic singularity approaches close the physical region and may affect on two pion mass distribution near $M_{\pi\pi} \sim 2$. According to the sign of the other terms of the amplitude the presence of this logarithmic singularity may either sharply increase the probability of the two pion production at $M_{\pi\pi} \sim 2$ or sharply decrease that one. The effect of decreasing pion production probability may be observed in the reaction $\pi^- + p \to n + \pi^+ + \pi^-$ at $E_\pi \sim 300 - 600$ MeV. At $E \geq 700$ MeV this logarithmic singularity removes from the physical region and ceases to have an effect on the pion spectrum. The latest effect also is observed in the reaction

$$\pi^- + p \to n + \pi^+ + \pi^-$$

We may explain analogically the experimental data on the reaction $p + d \to He_3 + 2\pi$. We suppose that this process may proceed through the production He_3 isobar and the following scattering of pions on each other. The experiments were carried out by Abashian, Booth and Crow at $E_p \sim 600 - 700$ MeV. At such an energy the logarithmic singularity approaches close the physical region of the reaction and may stinulate pion production probability at $M_{\pi\pi} \sim 2$ to increase sharply. In this reaction the logarithmic singularity must be removed from the physical region of $E_\pi \geq 1300$ MeV and at this energy the maximum in pion spectrum at $M_{\pi\pi} \sim 2$ should not be observed already.

IУ-5

ОБ ОПРЕДЕЛЕНИИ ХАРАКТЕРА $\pi\pi$ ВЗАИМОДЕЙСТВИЯ ПРИ НИЗКИХ ЭНЕРГИЯХ ИЗ ЭКСПЕРИМЕНТАЛЬНЫХ ДАННЫХ ПО $K \to 3\pi$ РАСПАДУ

В.В. Анисович

Физико-технический институт им. А.Ф. Иоффе
Ленинград, СССР.

Амплитуда $K \to 3\pi$ распада имеет особенности вблизи физической области. Эти особенности возникают от диаграмм, которые описывают рассеяние образовавшихся частиц друг на друге. Части амплитуд, имеющие особенности вблизи физической области распаде, существенным образом зависят от амплитуд рассеяния π -мезонов при нулевой энергии. Зависимость этих особых частей амплитуд от относительных импульсов образовавшихся π -мезонов отличается от зависимости частей амплитуды, аналитических вблизи физической области, и поэтому их можно отличить экспериментально. При этом оказывается возможным в принципе определить a_T (длину рассеяния π - мезонов в состоянии с изотопическим спином T).

Было проведено сравнение экспериментальных данных с теоретическими предсказаниями, полученными в предположении, что $a_T \lesssim \mu^{-1}$ (μ масса π -мезона). Оказалось, что теоретические формулы хорошо согласуются с экспериментальными данными, если только $|a_0 a_2| \lesssim 0{,}25/\mu^2$ Получить более точные сведения о длинах рассеяния из имеющихся в настоящее время экспериментальных данных не удается из-за сравнительно больших экспериментальных ошибок.

В связи с вопросом о существовании ABC-резонанса было проведено сравнение экспериментальных данных с теоретическими формулами, полученными для случаев, когда a_2 мало, а $a_0 = \mu^{-1}, 2\mu^{-1}, 3\mu^{-1}$. Оказалось, что экспериментальные данные согласуются с теоретическими кривыми лишь при $a_0 = \mu^{-1}$.

ON THE DETERMINATION OF THE CHARACTER OF π-π INTERACTION FROM THE EXPERIMENTAL DATA ON K→3π DECAY

V.V. Anisovich, A.F. Ioffe
Physical-Technical Institute, Leningrad,
U S S R

The $K \to 3\pi$ decay amplitude has the singularities near the physical region. These singularities appear from the graphs which describe the scattering of the particles produced by each other. The parts of the amplitude which have the singularities near the decay physical region, depend essentially fupon the pion scattering amplitude at zero energy. The dependence of these singular parts of the amplitude on the produced pion relative momenta differs from the dependence of those parts of the amplitude which are not analytical near the physical region; thus, they may be distinguished experimentally. As it was found, it is possible, in principe to determine α_T (pion length scattering for state with the isotopic spin T).

The comparision of the experimental data with the theoretical predictions, provided that $\alpha_T \leq \mu^{-1}$ (μ is the pion mass) was carried out. As it was found the theoretical formulae are in good agreement with the experimental data only if $|a_0 a_2| \leq 0.25 \mu^{-2}$. We have not succeded in receiving more exact information about scattering length from the experimental data available at the present time because of comparatively large experimental errors.

As far as the problem of ABC - resonance existence is concerned, we have compared the experimental data with the theoretical formulae written for the case when a_2 was small and $a_0 = 1\mu^{-1}$, $2\mu^{-1}$, $3\mu^{-1}$. As it was found, the experimental data agree satisfactorily with the theoretical curves only when $a_0 = 1\mu^{-1}$.

IУ-7

ПРИМЕНЕНИЕ КВАЗИПОТЕНЦИАЛЬНОГО МЕТОДА К РАССЕЯНИЮ МЕЗОНОВ НА НУКЛОНАХ

П.С.Исаев, Д. Смит.

Объединенный институт ядерных исследований
Лаборатория теоретической физики

Квазипотенциальный метод, предложенный Логуновым и Тавхелидзе, применяется к решению задачи о рассеянии π - мезонов на нуклонах в области энергий до 500 Мэв с целью получения резонансного поведения P_{33} фазы в рассматриваемой области энергии.

IY-7

AN APPLICATION OF QUASIPOTENTIAL METHOD TO πN - SCATTERING

P.S.Isaev, J. Smith

Joint Institute for Nuclear Research
Dubna

The quasipotential method suggested by Logunov and Tavkhelidze is applied to the problem of πN scattering in the energy region up to 500 MeV to obtain the resonance behaviour of the P_{33} phase shift in the energy region given.

BOOTSTRAP DYNAMICS AND PARTICLE SYMMETRIES

R.E.Cutkosky, M.Leon and K.Y.Lin

Physics Department, Carnegie Institute of Technology
Pittsburg, Pennsylvania, USA

1. Formulation of Bootstrap Models. Bootstrap models involve the analyticity and crossing symmetry of the S-matrix, and an assumed "boundary condition" to represent the hypothesis that all particles can be considered to be composite. The most convenient way to formulate these conditions seems to be through the Bethe--Salpeter equation, which avoids two difficulties of the more usual N/D formalism. In the N/D method, the problem of subtractions, which also involves the Regge-Pole analysis of cross -channel reactions, is not yet well understood. Also, the three lines joining at a vertex are not treated symmetrically. In the B-S formalism, a natural sequence of successive approximations automatically maintains " vertex symmetry".

As an example, Chew's reciprocal bootstrap model of the nucleon has been examined. It has been found that violation of vertex symmetry is a serious defect in previous treatments of this model, and that the treatment of the cut-off has been over simplified. However, the basic physical ideas underlying this model seem to be valid.

II. Origin of Particle Symmetries. We have examined various models which illustrate the way in which particle symmetries arise through the bootstrap mechanism. Previous work on a vector meson model is being extended, and also the interactions between mesons and baryons are being considered, in a modified static model.

THE POSSIBLE DYNAMICAL ORIGIN OF THE SET OF STRONGLY INTERACTING PARTICLES

RICHARD H. CAPPS

NORTHWESTERN UNIVERSITY
EVANSTON, ILLINOIS

The possibility that the self-consistency requirements of a dispersion-theoretic bootstrap model may determine the nature of the set of strongly interacting particles is considered. Attention is limited to sets of particles corresponding to a few representations of a simple Lie group of rank one or two. Two self-consistency requirements are considered. The first is the usual condition that the force of attraction is greatest in the channels corresponding to the particles of lowest mass. The second condition is related to the hypothesis that the physical particle multiplets should not be degenerate. It is shown on the basis of some simple properties of the crossing matrices and of the Clebsch-Gordan coefficients for the group-representation schemes in question that the most favored group is SU_3, and the most favored representations within this group are the singlet, octet, and decuplet representations.

DYNAMICAL MODEL OF MASS DIFFERENCES IN SU_3 PARTICLE MULTIPLETS

RICHARD H. CAPPS

NORTHWESTERN UNIVERSITY
EVANSTON, ILLINOIS

An approximate, dispersion-theoretic bootstrap model of the pseudoscalar meson octet and vector meson octet is considered. It is shown that the experimental values of the pseudoscalar meson masses lead to a predicted value of m_ρ/m_{K^*} in the range $(m_\pi/m_K) < (m_\rho/m_{K^*}) < 1$, and a predicted value of the coupling constant ratio $(g_{K^*K\pi}/g_{\rho\pi\pi})^2$ larger than that corresponding to exact SU_3 symmetry. These predictions are in agreement with experiment. The assumption that all the mass differences are self-generating leads to relations too complicated to be solved without drastic approximations; however, it is argued that this assumption leads to a negative $\pi - K$ mass difference and mass splittings predominantly of the type corresponding to the Gell-Mann-Okubo sum rule.

SEMI-DYNAMICAL BOOTSTRAPS

D.Morgan

Rutherford High Energy Laboratory, Chilton, Berkshire, England

We consider the problem of explaining the pseudo-vector resonances (p, K^{*}, ϕ) dynamically. We study in terms of partial wave dispersion relations the scattering problem with forces produced by the exchange of pseudo-vector systems. Such forces are marginally singular. We show that for attractive forces the phase shift at infinite positive energy δ_{∞} tends in general to a positive value between 0 and $\pi/2$ but that for a sub class of forces δ_{∞} tends to a value between $\pi/2$ and π . We conjecture that this latter situation may be relevant to the bootstrap problem.

IУ-I2

РАСЧЕТ МАССЫ А.В.С. МЕТОДОМ БУТСТРЭП

С. Чулли, Г.Гика

Институт ядерной физики Румынской АН (Бухарест)

Так как обе длины рассеяния для ПП положительны Д.Аткинсон доказал существование реального полюса на второй Риманнской поверхности амплитуды $T = 0$, $\ell = 0$.

В настояще работе проводится расчет типа Аберс-Захариасен-Земах с целью получить значение массы этого антисвязанного состояния.

Полученное значение очень близко порогу упругого рассеяния П-П и таким образом согласуется с экспериментальными данными для частиц А.В.С.

A BOOTSTRAP CALCULATION OF THE MASS OF THE ABC MESON

S.Ciulli and Gr.Ghika

Institute of Nuclear Physics, Bucharest, Rumania

Starting from the positiveness of the two pion-pion scattering lenghts, D.Atkinson recently proved the existence of a real pole on the second Riemann sheet of the T=0, l=L amplitude. In the present paper, performing a bootstrap calculation of Abers-Zachariasen-Zemach type, we calculate the value of the mass of this antibound state.

The obtained value is very close to the $\pi - \pi$ elastic scattering threshold, and therefore consistent with the experimental data on the ABC particle.

IУ-I3

ТЯЖЕЛЫЕ МЕЗОНЫ И ЛОКАЛЬНЫЙ NN ПОТЕНЦИАЛ

В.В.Бабиков, И.Быстрицкий и Ф. Легар

Объединенный институт ядерных исследований
Дубна

Предполагается, что основной вклад в ядерные силы обусловлен обменом тяжелыми мезонами. Строится соответствующий нуклон-нуклонный потенциал, имеющий вид суперпозиции потенциалов Юкавы. Используются известные массы и квантовые числа следующих мезонов: π, η, ρ, ω, φ и φ' (предполагается, что векторные мезоны $B^{\pm}$ и ϕ^{0} образуют один изотопический триплет I = I). Вводятся также два гипотетических скалярных мезона S_0 (I = 0) и S_1 (I =I). Эффективные константы связи мезонов с нуклоном и массы скалярных мезонов определяются из сравнения вычисленных с помощью данного потенциала параметров NN рассеяния с имеющимися экспериментальными данными по упругому NN рассеянию.

IY-13

HEAVY MESONS AND LOCAL NUCLEON-NUCLEON POTENTIAL

V.V.Babikov, J.Bystricky, F.Lehar

Joint Institute for Nuclear Research
Dubna

It is assumed that the main part of the nuclear forces is due to heavy meson exchange. The corresponding nucleon--nucleon potential as a superposition of Yukawa- type potentials is constructed. Use is made of the known masses and quantum numbers of the following mesons: $\pi, \eta, \rho, \omega, \varphi$ and ρ' (vector mesons $B^{\pm}$ and f^0 are supposed to form a common isotopic triplet state I=1). Two hypothetical scalar mesons $S_0(I=0)$ and $S_1(I=1)$ are introduced as well. The effective coupling constants and scalar meson masses are determined from the comparison of the nucleon-nucleon scattering parameters calculated by this potential with the available experimental data on elastic NN scattering.

ONE BOSON EXCHANGE MODEL IN NUCLEON-NUCLEON SCATTERING

S.Sawada

Department of Physics, Hiroshima University, Hiroshima ,Japan

and

T.Ueda

Department of Applied Mathematics, Faculty of Engineering Science, Osaka University, Toyonaka, Osaka, Japan

and

W.Watari

Research Institute for Atomic Energy, Osaka City University, Osaka, Japan

and

M.Yonezawa

Research School of Physical Sciences, The Australian National University, Canberra, Australia

In a previous paper a model for strong reaction has been proposed. Based on this model, proton-proton scattering has been analysed by the one-boson exchange-contribution model. In this paper we discuss both proton-proton scattering and neutron-proton scattering, using the observed masses for vector bosons, etc. It is shown that the model can well explain the nucleon-nucleon scattering for angular momentum $\ell \geq 1$, if we consider the contributions from pion, ω - meson, ρ-meson and I=0 scalar boson with mass 500 ~ 700 MeV. The effect of η meson I=1 scalar boson etc. are also discussed.

NUCLEAR INTERACTION OF CORE REGION

Shoichiro Otsuki

Department of Physics, Nagoya University, Nagoya

Ryozo Tamagaki and Masanobu Wada

Department of Physics, Hokkaido University, Sapporo

In the former half of the paper, the singlet S phase shift δ_0 is calculated by assuming a nuclear potential with a soft core of the Yukawa shape, the Gaussian shape, or the modified Gaussian shape $\exp\{-(\varkappa x)^\gamma\}$ surrounded by an attractive well with the one-pion-exchange tail. It is shown that the short-tailed soft core as the Gaussian or the modified-Gaussian shape can explain the behaviour of δ_0 upto 1 GeV while the long-tailed core such as the Yukawa shape can not reproduce δ_0 even in the energy region $0 \sim 200$ MeV. It is argued that the explanation of the origin of the soft core in terms of a vector-meson-exchange is rather improbable. The effective radius of the soft core is found to be $0.4 \sim 0.5$ fm and the effective height a few GeV.

In the latter half of the paper, it is pointed out that the nuclear interaction may have different nature outside and inside the effective core radius, by investigating the energy dependence of the absorption coefficient versus the impact parameter. The strong repulsion at low energies and the strong absorption at tens GeV, which are characteristic to the inner part, could be regarded as a manifestation of degrees of freedom inherent in the core region. Importance of the nucleon-nucleon polarization measurement in the GeV energy region as well as the measurement of the four momentum transfer in the cosmic ray nuclear interactions are discussed in order to go one step further in clarifying the core region interaction. A hypothetical interpretation on the substantial carrier of the degrees of freedom is proposed based on an analogy with nucleus that the carrier is a many-body-system of ur-fermions. The core is interpreted as the exchange repulsion due to the antisymmetrization among the ur-fermions.

IY-16

πP PHENOMENOLOGY AT INTERMEDIATE ENERGIES

P.Auvil, A.Donnachie, A.Lea and C.Lovelace

Imperial College and University College, London

We analyse πp scattering in the region above 300 MeV, by calculating the higher partial waves from dispersion relations, and fitting the lower ones to experiment. We expect to have a complete phase-shift analysis up to 700 MeV, and qualitative results at higher energies. Especially, we will discuss the evidence for Roper's P_{11} resonance, and for woolly cusps.

PION NUCLEON SCATTERING UP TO 700 MeV

R.G.Moorhouse

Rutherford High Energy Laboratory, Chilton, Berkshire, England

The pion- nucleon T=½ and T=3/2 elastic partial wave scattering amplitudes are parametrised as functions of energy. This is performed by parametrising in each partial wave the inelasticity and the left-hand cut, or forces, and obtaining the amplitude by using partial wave dispersion relations. The parameters are then determined by fitting to experiments at a large number of energies simultaneously, up to 700 MeV. Results for s,p,d,f,g partial waves are presented.

IУ-I8

РЕЛЯТИВИСТСКИЕ ПОПРАВКИ К S И p - ВОЛНАМ πN - РАССЕЯНИЯ

П.С. Исаев, В.А. Мещеряков, Г.М.Радушкин,
А.Н. Табаченко

Объединенный институт ядерных исследований
Лаборатория теоретической физики

В работе проведен расчет релятивистских поправок к $S^{(-)}$ -волне πN - рассеяния. Проведено сравнение с нерелятивистским расчетом. Показано, что: а) учет $\pi\pi$ - взаимодействия необходим для правильного описания энергетического поведения $S^{(-)}$ фазы πN - рассеяния, б) в рассматриваемом методе расчета релятивистские поправки малы; в) при более точном экспериментальном определении малых фаз πN - рассеяния в области энергии до 300-400 Мэв есть надежная возможность выделения $\pi\pi$ - взаимодействия и определения его параметров (длина рассеяния и положения резонанса).

IY-18

RELATIVISTIC CORRECTIONS TO S AND P WAVES OF PION-NUCLEON SCATTERING

P.S.Isaev, V.A.Meshcheryakov, G.M.Radutsky and A.N.Tabachenko

Joint Institute for Nuclear Research
Dubna

The relativistic corrections to the $S^{(-)}$ wave of pion-nucleon scattering are calculated. A comparision is made with the non-relativistic calculation. It is shown that: a) the account of pion-pion interaction is necessary to describe correctly the energy behaviour of the $S^{(-)}$ phase shift of pion-nucleon scattering, b) in the considered method of calculation the relativistic corrections are small c) there is a reliable possibility to determine the pion- pion interaction and find its parameters (scattering wave length and the resonance position). For this a more exact experimental measurement of the small phase shifts of pion- nucleon scattering is needed.

IУ-I9

ПОРОГОВОЕ ПОВЕДЕНИЕ ПАРЦИАЛЬНЫХ АМПЛИТУД НЕУПРУГОГО ПРОЦЕССА

О.В.Канчели, С.Г. Матинян

Институт физики АН ГССР

Пороговое поведение парциальных амплитуд неупругого процесса на базе уравнения Шредингера хорошо известно [I] – оно характеризуется множителями типа Q^{L}, где Q тот импульс, по которому делается предельный переход, а L – значение соответствующего орбитального момента. В релятивистской теории, не оперирующей с понятием потенциала, основанной на значении аналитических свойств амплитуды рождения, пороговое поведение либо постулировалось по аналогии с результатами уравнения Шредингера, либо исследовалось на примере простейших полюсных диаграмм [2]. Помимо того, что значение порогового поведения парциальной амплитуды в релятивистской теории, не использующей потенциала, представляет самостоятельный интерес, оно существенно для многочастичных условий унитарности парциальных амплитуд, в которых пределы интегрирования всегда соответствуют тем или иным порогам.

В настоящей работе показано, что парциальная амплитуда неупругого процесса, например, $a+b \to c+d+e$,

$$\chi_{j\ell\lambda}\left(S_{ab}, S_{cd}\right) = \frac{1}{2}\int_{-1}^{+1} P_j^{\lambda}(z)\,dz\,\frac{1}{2}\int_{-1}^{+1} dz_1\, P_\ell^{\lambda}(z_1)\,\frac{1}{2\pi}\int_0^{2\pi} d\varphi\, \cos\lambda\varphi\, A\left(S_{ab}, S_{cd}, z, z_1, \varphi\right) \qquad (1)$$

(в (I) j –полный момент, e и λ – относительный момент и спиральность частиц cd, z – угол между $\vec{p}_a^{\,*}$ и $\vec{p}_c$ (в с.ц.и. частиц a и b), z_1 – угол между частицами d и e (в с.ц.и. частиц c, d), φ – угол между плоскостями $(\vec{p}_a, \vec{p}_c)$ и $(\vec{p}_c, \vec{p}_d)$) при довольно общих предположениях об аналитических свойствах амплитуды неупругого процесса $A(\ldots S_{ik} \ldots)$ в комплексной плоскости инвариантов S_{ik}, характеризуется следующим поведением при стремлении к нулю импульса Q относительного движения частицы e и комплекса (cd):

$$\chi_{je\lambda} = \alpha_\perp Q_j\left(\frac{\alpha}{Q}\right) P_e\left(\frac{\alpha}{a}\right), \quad Q \to 0 \qquad (2)$$

где α, a – константы ($j > e$). При $j < e$ j и e в (2) меняются местами. Это поведение соответствует пороговому поведению $\chi_{je\lambda}$ вида $Q^{(j-e)}$ в теории с уравнением Шредингера и может служить обобщением на случай комплексных значений j и e.

Рассмотрение обобщается на произвольное число частиц в конечном состоянии.

THRESHOLD BEHAVIOUR OF PARTIAL AMPLITUDES OF AN INELASTIC PROCESS

O.V.Kancheli, S.G.Matinyan

Institute of Physics of the Academy of Science of the Georgian SSR

Threshold behaviour of partial amplitudes of inelastic process is well known on the basis of Schroedinger equation [1], it is characterized by factors of Q^L type, where Q is the momentum along which the limiting transition takes place, and L is the value of the corresponding orbital momentum. In relativistic theory, which does not deal with the notion of potential, based on the value of analytical properties of production amplitude, the threshold behaviour was either postulated by analogy with the results of Schroedinger equation, or studied on the example of the simplest pole diagrams [2]. Besides the fact that the value of the threshold of partial amplitude behaviour in relativistic theory, which does not use potential, is interesting itself, it is important for multiparticle conditions of unitarity of partial amplitudes, in which limit of integration always corresponds to either threshold.

It is shown in the given work that the partial amplitude of an inelastic process such, for instance, as the following $a + b \to c + d + e$,

$$X_{j\ell\lambda}(S_{ab}, S_{cd}) = \frac{1}{2}\int_{-1}^{+1} P_j^{\lambda}(z)dz \,\frac{1}{2}\int_{-1}^{+1} dz_1 P_\ell^{\lambda}(z_1)\frac{1}{2\pi}\int_0^{2\pi} d\varphi \cos\lambda\varphi\, A(S_{ab}, S_{cd}, z, z_1, \varphi) \qquad (1)$$

(where j is the total momentum, ℓ and λ are the relative angular momentum and helicity of the particles c,d respectively, z is the cosine of angle between $\vec{P_a}$ and $\vec{P_c}$ (in the centre-of- mass system of particles a and b), z_1 is the cosine of angle between the d and 1) at rather general assumptions on analytical properties of the inelattic process amplitude $A(\ldots S_{ik} \ldots)$ in the complex plane of S_{ik} invariants, is characterized by the following behaviour when the momentum Q of the relative motion of the particle ℓ and complexes (c,d) tends to zero:

$$X_{j\ell\lambda} \propto Q_j\left(\frac{\alpha}{Q}\right) P_\ell\left(\frac{\alpha}{Q}\right), \quad Q \to 0 \qquad (2)$$

where α is the constant $j > \ell$. When $j < \ell$ then j and ℓ in formula (2) change their places. Such a behaviour corresponds to the threshold behaviour of $X_{j\ell\lambda}$ of the form $Q^{|j-\ell|}$ in the theory with Schroedinger equation and can be used as the generalization for the case of complex values of j and ℓ.

The consideration is generalized for an arbitrary number of particles in the finite state.

References:

1. L.Fonda, R.Newton. Phys.Rev.119, 1394 (1960).
2. L.Cook, B.Lee. Phys.Rev.127, 283 (1963).

IУ-20

ФЕНОМЕНОЛОГИЧЕСКАЯ МОДЕЛЬ ВЗАИМОДЕЙСТВИЯ НУКЛОНА С АНТИНУКЛОНОМ ПРИ НЕРЕЛЯТИВИСТСКИХ ЭНЕРГИЯХ

П.Э.Немировский, Ю.П. Елагин и
Ю.Ф. Строков

Институт атомной энергии им. Т.В. Курчатова,
Москва, СССР

Рассмотрено взаимодействие нуклона с антинуклоном при энергиях ниже порога рождения пионов. Для вычисления сечений аннигиляции, перезарядки и упругого рассеяния была использована оптическая модель. Параметры мнимой части потенциала для всех фаз и всех энергий брались, одинаковыми, а зависимость от r в виде $W = W_0 \exp\left\{-\left(\frac{r}{a}\right)^n\right\}$ с n =I,2,4. Действительная часть потенциала состояла из одномезонного взаимодействия, включая тензорную силу, и двух более короткодействующих потенциалов с радиусом 0,7 и 0,25 ферми. Влияние наиболее короткодействующего взаимодействия на сечения было ничтожно. Было исследовано также влияние спинорбитального взаимодействия как того же знака, что и у Сигнела и Маршака, так и противоположного знака.

Получено хорошее согласие с опытом в интервале 40-250 *Mev* в лабораторной системе для σ_a, σ_s, $\sigma_{c.e}$ и $d\sigma_s/d\Omega$ в системе $p\bar{p}$.

Показано, что для широкого класса комплексных взаимодействий отношение $(\sigma_s/\sigma_a) < 1$. Для малых энергий вычислены поправки на разность масс системы $p\bar{p}$ и $n\bar{n}$, а также влияние кулоновского поля. Вычислены также сечения σ_a, σ_s и $d\sigma_s/d\Omega$ для системы $\bar{n}p$.

THE PHENOMENOLOGIC MODEL OF NUCLEON-ANTINUCLEON INTERACTION IN THE NONRELATIVISTIC ENERGY RANGE

P.E.Nemirovskii, Yu.P.Elagin, Yu.F. Strokov

I.V.Kurchatov Atomic Energy Institute, Moscow, USSR.

The nucleon-antinucleon interaction in the energy range below pion threshold is considered.

The optical model if used for the calculation of annihilation, elastic scattering and charge exchange cross sections σ_a , σ_s , σ_{ce} respectively. The constants determining the imaginary part of the potential are taken the same for all phases and energies. The dependence on r is taken in the form $W = -W_0 \exp\left\{-\left(\frac{r}{a}\right)^n\right\}$ for n=1,2 and 4 . The real part of the interaction is chosen as the sum of single pion exchange and two interactions of shorter range 0.7 and 0.25 fermi respectively. The single pion exchange includes the tensor force.

The influence of the interaction of shortest range on the cross sections was found to be negligible. The real spin-orbit coupling of two signs (the same as by Signel and Marshak and of the opposite sign) is investigated.

For $p\bar{p}$ collisions of fair agreement with experiment in the energy range 40- 250 MeV in the laboratory system is obtained for σ_a , σ_s , σ_{ce} and $\frac{d\sigma_s}{d\Omega}$

It is shown that for a wide class of complex interactions the relation $\sigma_s < \sigma_a$ is satisfied. For low energies the Coulomb and $p\bar{p} - n\bar{n}$ mass difference corrections are computed. The cross sections σ_s , σ_a and $\frac{d\sigma_s}{d\Omega}$ for $\bar{n}p$ collisions are also given.

IУ-2I

ГИПЕРОННЫЕ РЕЗОНАНСЫ

М. Свенцки

Объединенный институт ядерных исследований x/
Лаборатория теоретической физики
Дубна

В работе построена самосогласованная модель для резонансных состояний системы пион-гиперон. Рассмотрено три сопряженных канала со странностью S =-I; $\bar{K}N$, $\pi\Lambda$, $\pi\Sigma$ предполагая, что силы, которые вырабатывают резонансы и связанные состояния происходят из-за обмена этих самых резонансов, связанных состояний и, добавочно, восьми векторных мезонов. Короткодействующие силы учтены с помощью полосового приближения (strip-approximation).
Чтобы обойти трудности связанные с расходимостью парциальных разложений все динамические сингулярности учтены с помощью обобщенного на многоканальные процессы приближения Балажа (Balazs). Полученные количественные результаты сравнены с экспериментальными данными и обсуждена их связь с моделью унитарной симметрии Гелл-Манна.

---

x/ Постоянный адрес: Институт ядерных исследований,
Варшава, Польша.

IY-21

HYPERON RESONANCES

M.Swiecki

Joint Institute for Nuclear Research
Dubna

In the paper the self-consistent (bootstrap) calculations for the pion-hyperon resonance states are performed. Three strangeness S = -1 couple channels $(\bar{K}N, \pi\Lambda, \pi\Sigma)$ are investigated, with the assumption that the forces, that produce the resonances and bound states result from the exchange of the same resonances, bound states and eight vector mesons in addition. The short-range forces are taken into account by strip-approximation. In order to avoid the complications which are connected with the divergence of partial- wave expansions, the generalized multichannel Balázs approximation is applied. Numerical results, which are obtained in this way are compared with experimental data. The connection of the results with Gell-Mann's unitary symmetry model is discussed.

IУ-22

ОБ АНОМАЛЬНЫХ ОСОБЕННОСТЯХ АМПЛИТУДЫ πD РАССЕЯНИЯ И DNN ВЕРШИНА

К.Библ, Ф.Кашлун

Институт теоретической физики университета им. Гумбалдта
и Институт физики высоких энергий Германской Академии наук
в Берлине.

Расчитывается вклад нефизической области в дисперсионное соотношение πD - рассеяния вперед в импульсном приближении. В частности учитывается аномальная ситуация, которая изучается при помощи аналитического продолжения амплитуды поглощения $\pi D \to NN$ в пионной массе. Найдено, что аномальная логарифмическая точка разветвления и аномальный полюс возникают в той же точке которая совпадает с точкой найденной другими методами. Показано, что спин флип дисперсионное соотношение может быть использовано для определения πN константой связи. Значение найдено применением импульсного приближения в физической области дисперсионного соотношения совпадает в пределах 10% со значением, полученным из соответствующего πN-дисперсионного соотношения. Для этого согласия весьма важно рассмотрение аномального полюса. Кроме того изучаются аномальные особенности DNN вершины связанные с двух и многочастичными промежуточными состояниями и сравниваются в нерелятивистском пределе с результатами потенциальной теории.

IY-22

ON THE ANOMALOUS SINGULARITIES OF THE π -D SCATTERING AMPLITUDE AND THE D-N-N VERTEX

Kl.-J.Biebl and F.Kaschluhn

Institut fur Theoretische Physik der Humboldt-Universitaet Berlin

and

Forschungsstelle fur Physik hoher Energien der Deutschen Akademie der Wissenschaften zu Berlin

The contribution of the unphysical region in the disperion relations for π -D forward scattering is calculated in impulse approximation. Special regard is taken to the anomalous situation which is studied by explicit analytic continuation of the absorption amplitude π +d $\rightarrow$ N + N in the pion mass. It is found that an anomalous logarithmic branch point and an anomalous pole appear at the same point which coincides with that found by other methods. It is shown that the spin-flip dispersion relation can be used for the determination of the pion-nucleon coupling constant. The value found by employing the impulse approximation in the physical region of the disperion relation agrees within 10% with that following from the corresponding π -N dispersion relation. For this agreement the consideration of the anomalous pole is quite important. In addition to this the anomalous singularities of the D-N-N vertex connected with two and many-particle intermediate states are studied and compared in the non-relativistic limit with the results of potential theory.

IY-23

MANY CHANNEL RESONANCE THEORY

M.Ross

University of Michigan, USA

The scattering amplitude describing many coupled two body channels, some open, some closed, is considered. The approximate form of the amplitude in the vicinity of a bound state or resonance is discussed. Special topics developed are: 1. threshold properties for s and higher waves, 2. narrowing of the resonance due to coupling to closed channels, 3. simple approximations for a background plus resonance amplitude for use instead of the one level resonance approximation, 4. coupling constant or partial width sum rules. Applications are made to the decuplet baryon resonances, where the theoretical validity of the Gell-Mann Okubo mass formula is investigated, and to the s wave pseudoscalar meson-baryon scattering lengths, where the possibility of determining the SU_3 multiplet structure of the s wave amplitude is examined in detail.

Interference Effects in Multimeson Resonances

W. R. Frazer, J. R. Fulco, F. R. Halpern, and S. H. Patil

University of California at San Diego, La Jolla, California

ABSTRACT

The problem of interference effects in "cascade" decays of multimeson resonances is discussed; that is, decays of the form $X \to Y + n$ mesons followed by $Y \to m$ mesons. Interference effects occur whenever there is more than one way to form the state $Y + n$ mesons out of the final $(m + n)$ mesons state. For example, there will be interference between the two modes

$$A^{o} \to \left\{ \begin{matrix} \rho^{+} + \pi^{-} \\ \rho^{-} + \pi^{+} \end{matrix} \right\} \to \pi^{+} + \pi^{-} + \pi^{o} \quad .$$

This case is discussed in detail, and results are presented for the B and the $K\bar{K}\pi$ resonance at 1410 Mev. The effect of experimental resolution is evaluated.

IY-25

$K \rightarrow e4$ DECAYS AND THE DETERMINATION OF LOW ENERGY PION-PION PHASE SHIFTS

Nicola Cabibbo

Lawrence Radiation Laboratory, University of California, Berkeley, California and Laboratori Nazionali del CNEN, Frascati, Italy

and

Alex Maksymowicz

Lawrence Radiation Laboratory, University of California, Berkeley, California, USA

The study correlations in the decay $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ allows the experimental determination of the difference between S- and P-wave phase shifts for those values of the $\pi^+\pi^-$ mass which are available in the decay. If a detailed study is not possible due to the limited number of events, it is still possible to test any given model for low energy $\pi^+\pi^-$ scattering. In particular one can obtain a measurement of the S-wave scattering length, and get in this way an independent confirmation of the analysis by Booth, Abashian and Crowe [1].

---

[1] N.E.Booth, A.Bashian, K.M.Crowe. Phys.Rev.Lett. 7, 35 (1961).

LAMBDA-NUCLEON POTENTIALS FROM SINGLE-PARTICLE EXCHANGES

B.W.Downs (Oxford University)
and
R.J.N.Phillips (Harwell)

The single-meson exchange potentials, corresponding to known pseudoscalar and vector mesons plus a nominal scalar particle, are considered, They give a reasonable fit to the existing data, through a range of plausible values for the coupling constants.

IV - 27

О ВЛИЯНИИ ЛОГАРИФМИЧЕСКИХ ОСОБЕННОСТЕЙ НА ПАРАМЕТРЫ НЕКОТОРЫХ РЕЗОНАНСОВ

В.В.Анисович, А.Н. Москалев,
В.В. Фомин

Физико-технический институт им. А.Ф. Иоффе
Ленинград, СССР

ON THE EFFECT OF LOGARITHMIC PECULIARITIES ON THE PARAMETERS OF SOME RESONANCES

V.V.Anisovich, A.N.Moskalev, V.V.Fomin

A.F.Ioffe Physical-Technical Institute, Leningrad, USSR

THE RELATION BETWEEN BOOTSTRAPPING AND STRONG COUPLING THEORY

G.Goebel

University of Wisconsin

The bootstrapping or self consistency conditions, in the static approximation of meson-baryon scattering, can be derived as the conditions on the pole terms of the scattering amplitudes, and hence on the couplings, such that the exact amplitude, obeying unitarity, exists. These conditions are restrictive when the coupling is strong, i.e. when well defined excited states of the scatterer (isobars) exist. Minimal bootstrapping schemes are defined as those choices of couplings such that as many isobars as possible are not coupled at all, and hence may be regarded as nonexistent. It is then found that these minimal bootstrapping schemes of isobars are identical with the ground state rotational bands of strong coupling theory, for those cases in which the latter has been worked out: πN, $\pi\Sigma$ s-wave and p-wave. Even the curious result of Wentzel, that in $\pi\Sigma$ s-wave either the $\pi\Sigma\Lambda$ or $\pi\Sigma\Sigma$ coupling must vanish, is reproduced. In SU_3, $\Pi N_{\frac{1}{2}}$ p-wave scattering has the minimal scheme $8_{\frac{1}{2}}, 10_{\frac{3}{2}}, \overline{10}_{\frac{1}{2}}, 27_{\frac{1}{2}}, 27_{\frac{3}{2}}$ with f-ratio $\frac{f}{f+d} = 1/2$. The couplings of $\overline{10}_{\frac{1}{2}}$ and $27_{\frac{1}{2}}$ are considerably smaller than the others, and so we have qualitative agreement with the models of Martin and Wali and with Capps.

IУ-29

ВЫБОР ОПЫТОВ ПО РАССЕЯНИЮ ЧАСТИЦ И ЕДИНСТВЕННОСТЬ ИХ АНАЛИЗА

Н.П. Клепиков

Научно-исследовательский институт ядерной физики МГУ,
Москва, СССР

IV-29

CHOICE OF PARTICLE SCATTERING EXPERIMENTS AND THE UNIQUENESS OF THEIR ANALYSIS

N.P.Klepikov

Moscow State University
Moscow, USSR

POSSIBLE APPLICATIONS OF A POLARIZED HYDROGEN TARGET IN HIGH ENERGY PHYSICS

S.M.Bilenky, L.I.Lapidus, R.M.Ryndin

Joint Institute for Nuclear Research
Dubna, USSR

Some applications of a polarized hydrogen target to problems of the reconstruction of the amplitudes of various processes are considered. Possible use of the polarized hydrogen target in studying electromagnetic and weak interactions as well as in determining the spins and parities of resonant states are indicated.

IУ-30

О ВОЗМОЖНЫХ ПРИМЕНЕНИЯХ ПОЛЯРИЗОВАННОЙ ВОДОРОДНОЙ МИШЕНИ В ФИЗИКЕ ВЫСОКИХ ЭНЕРГИЙ

С.М.Биленький, Л.И.Лапидус, Р.М. Рындин

Объединенный институт ядерных исследований
Лаборатория теоретической физики
Дубна

Рассматриваются применения поляризованной водородной мишени (п.в.м.) в задачах о восстановлении амплитуд различных процессов. Указаны возможные применения п.в.м. при изучении электромагнитных и слабых взаимодействий, а также при определении спинов и четностей резонансных состояний.

IУ-3I

ПОЛЯРИЗАЦИЯ РЕЛЯТИВИСТСКИХ ЧАСТИЦ

А.З.Долгинов, А.Н. Москалев

Институт теоретической и экспериментальной физики, Москва, СССР

Развит новый формализм для описания релятивистских частиц с произвольным спином. Получено явное выражение для их волновых функций. Установлена связь волновых функций с неприводимыми представлениями группы Лоренца и закон их преобразования при 4-мерных вращениях и C, P и T отражениях. Построены релятивистские поляризационные операторы, которые являются обобщением операторов мультипольных моментов. Получена релятивистская матрица плотности частиц с произвольным спином. Дано разложение амплитуды реакции по бесконечномерным представлениям группы Лоренца.

IV-31

POLARIZATION OF THE RELATIVISTIC PARTICLES

A.Z.Dolginov, A.N.Moskalev

Institute of Theoretical and Experimental Physics
Moscow, USSR

A new formalism for description of relativistic particles with arbitrary spin is developed and an explicit form of their wave functions is obtained. The connection between wave functions and the irreducible representations of the Lorentz group is established, as well as the behaviour of the wave functions under 4-dimensional rotations and C, P and T reflections. The relativistic polarization operators are constructed which are a generalization of the multipole momentum operators. The relativistic density matrix of the particles with arbitrary spin is also obtained. The reaction amplitude is expanded over infinite dimensional representations of the Lorentz group.

A COVARIANT APPROACH TO CALCULATION OF THE SPIN 0, I/2 AND 1 PARTICLES

A.A.Bogush and F.I.Fedorov

Institute of Physics
of the Belorussian Academy of Sciences

The proposal method is based on direct calculation of the matrics elements of an amplitude. It have not any connection with explicite form of matrices and functions, and in view of this fact is consequently covariant. For the aim of application the matrix elements for different polarisation are tabulated. The approach may be useful in the case if one accounts for both isotopic and spin properties of particles.

ONE BOSON EXCHANGE MODEL IN NUCLEON-NUCLEON SCATTERING

S.Sawada
Department of Physics, Hiroshima University, Hiroshima
and
T.Ueda
Department of Applied Mathematics, Faculy of Engineering Science, Osaka University, Toyonaka, Osaka
and
W.Watari
Research Institute for Atomic Energy, Osaka City University, Osaka
and
M.Yonezawa
Research School of Physical Sciences, The Australian National University, Canberra

In a previous paper a model for strong reaction has been proposed. Based on this model, proton-proton scattering has been analysed by the one-boson exchange contribution model. In this paper we discuss both proton-proton scattering and neutron-proton scattering, using the observed masses for vector bosons, etc. It is shown that the model can well explain the nucleon-nucleon scattering for angular momentum 1, if we consider the contributions from pion, -meson, -meson and l=0 scalar boson with mass 500 700 MeV. The effects of , -meson, I = 1 scalar boson etc. are also discussed.

КОВАРИАНТНЫЙ МЕТОД РАСЧЕТА АМПЛИТУД РЕАКЦИЙ ЧАСТИЦ СО СПИНОМ 0,I/2 и I

А.А.Богуш, Ф.И. Федоров

Институт физики АН БССР, СССР

Предлагаемый метод основан на непосредственном расчете входящих в амплитуду матричных элементов. Он не связан с заданием конкретного базиса матриц и функций и в этом смысле является последовательно ковариантным. Для практического использования составлены таблицы матричных элементов между состояниями с различными поляризациями. Метод пригоден в случае одновременного учета спиновых и изотопических свойств.

COVARIANT METHOD OF CALCULATING PARTICLE REACTION AMPLITUDES WITH SPIN 0, 1/2 AND 1

A.A.Bogush, F.I.Fedorov

Minsk Institute of Physics, Minsk, BSSR

У

ВЗАИМОДЕЙСТВИЯ ПИОНОВ И НУКЛОНОВ (выше I Гэв)

Теория

INTERACTIONS OF PIONS AND NUCLEONS (above 1 GeV)

Theoretical

У-I

УРАВНЕНИЕ БЕТЕ-СОЛПИТЕРА И РОЛЬ ЦЕНТРАЛЬНЫХ ВЗАИМОДЕЙСТВИЙ

И.М.Дремин, И.И.Ройзен, Р.Б.Уайт,
Д.С.Чернавский

Физический институт Академии наук СССР

Исследованы условия и свойства ядра уравнения, при которых упругое взаимодействие имеет канонический реджевский характер, а также свойства ядра, соответствующие различным моделям неупругих взаимодействий при высоких энергиях (двухцентральная модель, полностью периферическая модель).

Предлагаются также другие модели, в частности, модель которая приводит при высокой энергии к неубывающему сечению дифракционного рассеяния и в то же время удовлетворяет условию унитарности.

THE BETHE-SALPETER EQUATION AND THE ROLE OF THE CENTRAL INTERACTIONS

D.S.Chernavsky, I.M.Dremin, I.I.Royzen, R.B.White

P.N.Lebedev Physical Institute, Moscow, USSR

Conditions on the kernel are found which guarantee that the scattering amplitude has the canonical Regge form in the case of elastic scattering. Special assumptions made concerning the nature of the kernel give respectively different models for inelastic scattering at high energy (one pion exchange model , multiperipheral model).

Other models are proposed, in particular a model which has at high energy a non-decreasing diffraction scattering form, and which at the same time satisfies the unitarity condition.

У-2

ЦЕНТРАЛЬНЫЕ И ПЕРИФЕРИЧЕСКИЕ ВЗАИМОДЕЙСТВИЯ ЧАСТИЦ ВЫСОКОЙ ЭНЕРГИИ

И.М.Дремин, И.И.Ройзен, Р.Б.Уайт,
Е.Л.Фейнберг, Д.С.Чернавский

Физический институт им. П.Н.Лебедева АН СССР

Проблема сильных взаимодействий частиц высоких энергий рассматривается на основе уравнения для двухчастичной функции Грина (уравнения Бете-Солпитера).

Ядро этого уравнения связано с сечением центральных взаимодействий, что позволяет выделить вклад центральных и периферических взаимодействий и выяснить их взаимную связь.

CENTRAL AND PERIPHERAL INTERACTIONS OF ELEMENTARY PARTICLES AT HIGH ENERGY

D.S.Chernavsky, I.M.Dremin, E.L.Feinberg, I.I.Roysen and R.B.White

P.N.Lebedev Physical Institute , Moscow, USSR

The nature of interactions at high energy is examined with the use of equation for two-particles Green functions (Bethe-Salpeter equations) .

The kernel of this equations is related with the cross section of the central interactions it permit one to distinguish the contributions of the central and peripheral part of the interactions and to examine their relations to one another.

ВКЛАД ОДНОЧАСТИЧНЫХ ОБМЕНОВ В НЕУПРУГИЕ НУКЛОН-НУКЛОННЫЕ И ПИОН-НУКЛОННЫЕ ВЗАИМОДЕЙСТВИЯ

И.Г.Голяк, И.А.Кучин, В.И.Руськин,
Ж.С.Такибаев, П.А.Усик.

Институт ядерной физики АН Казахской ССР

Рассматривается роль одночастичных обменных процессов (обмен пионом или резононом) в нуклон-нуклонных и пион-нуклонных взаимодействиях при энергии выше I Гэв.

Путем сравнения расчетных данных с экспериментальными показано, что указанные процессы играют значительную роль. В случае пион-нуклонных взаимодействий при ускорительных энергиях выяснена важная роль обмена резононом или связанной нуклон-антинуклонной системой с массой около 2 Гэв. Изотопический анализ в ряде случаев позволяет оценить вклад отдельных полюсных процессов. В случае протон-нейтронных взаимодействий при энергиях IO-20 Гэв учет одночастичного обмена позволяет объяснить асимметрию разлета вторичных протонов, найденную в экспериментах ИЯФ АН КазССР.

В рамках развиваемой схемы показано, что основная часть неупругого нуклон-нуклонного рассеяния при энергиях более IO^{II} эв обусловлена процессами промежуточного пион-пионного взаимодействия без возбуждения нуклонов.

CONTRIBUTIONS OF ONE-PARTICLE EXCHANGES TO INELASTIC N-N AND π-N INTERACTIONS

I.G.Golyak, I.A.Kuchin, V.I.Ruskin, G.S.Takibaev, P.A.Usik

Institute for Nuclear Physics, Kazakh. SSR, USSR

РОЛЬ ПЕРИФЕРИЧЕСКИХ ВЗАИМОДЕЙСТВИЙ В НУКЛОН-АНТИНУКЛОННЫХ ПРОЦЕССАХ.

И.Г. Голяк, В.И. Руськин, Ж.С.Такибаев

Институт ядерной физики АН Казахской ССР

Нуклон-антинуклонные взаимодействия при нескольких значениях энергии анализируются с точки зрения различных моделей (главным образом с точки зрения полюсного метода и теории периферических взаимодействий).

Показано, что как в процессах нуклон-антинуклонного рассеяния (упругого и неупругого), так и в процессах аннигиляции большую роль играют П-мезонные резонансы.

В случае упругого нуклон-антинуклонного рассеяния получено указание на важность обмена резононом с массой около 300 Мэв. Основную часть экспериментальных данных о нуклон-антинуклонной аннигиляции можно объяснить процессами, в которых в конечном состоянии образуются две частицы (одна или обе из которых могут быть резононами).

Y- 5

THE ROLE OF PERIPHERAL INTERACTIONS IN NUCLEON-ANTINUCLEON PROCESSES

I.G.Golyak, V.I.Rus'kin, Zh.S.Takibaev

Institute for Nuclear Research, Kazakh. SSR, USSR

V-6

О МЕХАНИЗМЕ ОБРАЗОВАНИЯ И ПРИРОДЕ ФАЙР-БОЛОВ

М.Т.Жумартбаев, Л.А.Санько,
Ж.С.Такибаев, П.А. Усик.

Институт ядерной физики АН Казахской ССР

Исследованы угловые распределения ливневых частиц в струях с $\mathcal{N}_h \leq 2$ при энергиях первичных частиц $E \geq 10^{11}$ эв.

На основании анализа противоречий, возникающих при сравнении результатов модели файр-болов с экспериментальными данными по струям показана ограниченность этой модели.

Сформулирована новая модель - модель промежуточных резонансов и барионных пар, основывающаяся на гидродинамическом описании разлета возбужденной системы, образующейся при взаимодействии виртуальных пионов.

Суть модели состоит в учете большой вероятности образования тяжелых промежуточных частиц в стадии распада простых волн.

Показано, что учет релаксаций в гидродинамической системе равносилен введению вязкости.

С точки зрения предлагаемой модели интерпретируются наблюдаемые характеристики струй.

Результаты обобщены на случай взаимодействия нуклона со сложным ядром.

ON THE PRODUCTION MECHANISM AND THE NATURE OF FIRE-BALLS

M.T.Zhumartbayev, L.A.Sanko, Zh.C.Takibayev
and P.A.Ussik

Institute for Nuclear Physics, Kazakh. SSR

INFLUENCE OF ABSORPTION DUE TO COMPETING PROCESSES ON PERIPHERAL REACTIONS

by

K. Gottfried and J.D. Jackson
CERN-Geneva

The peripheral or one-meson exchange model is modified to include absorptive effects due to competition from other inelastic channels. These effects are most important for small impact parameters (low partial waves) and produce appreciable reduction in cross-section and a pronounced collimation of the angular distribution. The absorption thus provides a natural explanation of the highly peaked angular distributions previously ascribed to ad hoc form factors. The necessary information concerning the absorption is inferred from the elastic scattering in the initial and final state in a manner first proposed by Sopkovich. Becuase of the importance of the decay correlations of resonances produced in these reactions, the spins of the particles are treated in a consistent way. It is found that a proper treatment of the spins is also essential in evaluating the angular distribution of production. Quasi-two-body peripheral reactions from πN and KN collisions at a few GeV/c are analyzed in detail. For πN reactions in which the coupling constants are known, the theoretical cross-sections are in good agreement with experiment, both as to angular dependence and absolute value. The spin density matrices of the resonances are found to be altered somewhat from the unmodified one-meson-exchange result, especially at larger production angles, but the gross decay correlation characteristics of the simple exchange model are still preserved.

PERIPHERAL MODEL FOR ρ AND $\rho\pi$ PRODUCTION

R. Deck, M. Ross, G. Shaw

University of Michigan, USA

Two peripheral model calculations are reported. The first is of the reaction $\pi+N \to \rho+\pi+N$, by one pion exchange. For the $\pi+N \to \pi+N$ vertex an exponentially forward peaked differential cross section is used which fits πN elastic scattering above about 1 BeV lab. energy. The absolute cross section, the $\rho\pi$ mass distribution and momentum transfer to the nucleon agree rather well with recent experiments. The experimental peaking at low $\rho\pi$ mass which disagrees with phase space has been previously interpreted in terms of an attractive $\rho\pi$ final state interaction or a $\rho\pi$ resonance.

In the second calculation the effects of unitarity on the peripheral calculation of $\pi+N \to \rho+\pi$ are considered. The experimental πN elastic and absorption cross sections as calculated in perturbation theory, must be suppressed. This is an expression of competition with other channels, analogous to distorted wave Born approximation calculations. Our calculation of the absorption effects reveals strong suppression of ρ production even at forward angles. Most ρ's do not escape from the nucleon. We speculate that those that do, especially at larger angles, will be strongly modified in width, energy, and polarization. Some experimental evidence of this dependence of properties on momentum transfer has already been found.

PRODUCTION AND DECAY OF NUCLEON ISOBARS

L. Chang and Z. Koba

Institute for Theoretical Physics, Copenhagen

On the basis of the working hypothesis that a predominant fraction of the nucleon-nucleon interaction at 1 - 30 Gev takes place through excitation of one or both of the colliding nucleons into non-strange baryon resonance states and subsequent decay of the latter, or schematically,

$$
\begin{aligned}
N + N &\longrightarrow N + N, && (1a)\\
&\searrow N + N_i^*, && (1b)\\
&\searrow N_i^* + N_j^*; \quad (i,j = 1,2,3,\ldots), && (1c)\\
N_i^* &\longrightarrow N + m\pi, \quad (m = 1,2,3,\ldots), && (2a)\\
&\searrow Y + K + n\pi, && (2b)\\
&\searrow N + K + \bar{K} + n\pi, \quad (n = 0,1,2,\ldots), && (2c)
\end{aligned}
$$

we calculate the cross sections and angular distributions for (1a)-(1c), and relative abundance of the decay products in (2).

The production processes are evaluated (i) by constructing a unitary and symmetric S-matrix with the help o f phenomenological analysis, and (ii) by applying the one meson exchange model. In estimating the decay processes the various resonance states and unitary symmetry are taken into account.

АНАЛИЗ УГЛОВЫХ РАСПРЕДЕЛЕНИЙ ВТОРИЧНЫХ ЧАСТИЦ В НУКЛОН-НУКЛОННЫХ СТОЛКНОВЕНИЯХ ПРИ УЛЬТРА-ВЫСОКИХ ЭНЕРГИЯХ

Р. Рончка

Объединенный институт ядерных исследований

Лаборатория теоретической физики

Рассматриваются угловые распределения вторичных частиц, образующихся в нуклон-нуклонных соударениях в интервале энергий $10^{12}_{эв} \leqslant E \lesssim 10^{14}_{эв}$. Хорошо известно, что в этой области энергий наблюдаются характеристические распределения, имеющие два максимума. Чтобы объяснить это явление, мы предполагаем модель, которая основывается на периферийности столкновения в рассматриваемой области энергий. Используя точное выражение для амплитуды перехода в представлении углового момента для N релятивистских частиц и используя преобладание периферийности нуклон-нуклонного столкновения, мы получаем при довольно очевидных предположениях окончательное выражение для углового распределения вторичных частиц. Построив кривую для углового распределения в координатах $y = \frac{dN}{dx}$ и $x = \lg \operatorname{tg} \frac{\vartheta}{2}$, Мы получаем угловое распределение с двумя максимумами. Если энергия нуклон-нуклонного соударения изменяется от $10^{12}_{эв}$ до $10^{14}_{эв}$, минимум углубляется, а максимумы раздвигаются, что находится в качественном согласии с экспериментальными данными.

Наши результаты говорят о том, что нет необходимости использовать динамическую модель сгустков для объяснения основных свойств нуклон-нуклонных соударений в области ультра высоких энергий.

ANALYSIS OF ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES IN ULTRA-HIGH ENERGY NUCLEON COLLISION

R.Roczka
Joint institute for Nuclear Research
Laboratory of Theoretical Physics

We consider the angular distribution of secondary particles created in nucleon-nucleon collisions in the energy interval $10^{12}_{ev} \leq E \leq 10^{14}_{ev}$. It is well known that the characteristic two maximum distributions were observed in this energy region.

To explain this fact we propose some mode which is based on peripherality of collision at energies considered. Using the exact expression for the transition amplitude in the angular momentum representation for N relativistic particles and taking advantage of the peripherality of N-N collision we obtain under very natural assumptions the final expression for the angular distribution of secondary particles. If we plot the curve for the angular distribution in the coordinates $y = \frac{dN}{dx}$, $x = lg\, tg \frac{\vartheta}{2}$, we obtain the two maximum angular distributions. If the energy of the N-N collision is changed from 10^{12}_{ev} up to 10^{14}_{ev} the minimum becomes deeper and the maxima are extended in qualitative agreement with the experimental data. Our results suggest that there is no necessity to introduce the dynamical five-ball model to explain the characteristic features of N-N collisions at ultra-high energies.

У-II

СРАВНЕНИЕ УГЛОВОГО РАСПРЕДЕЛЕНИЯ ВТОРИЧНЫХ ЧАСТИЦ В СТРУЯХ СВЕРХВЫСОКОЙ ЭНЕРГИИ С КВАЗИ-ПРЯМОУГОЛЬНЫМ РАСПРЕДЕЛЕНИЕМ

Я.Бабецки, М.Менсович

Институт ядерных исследований, Лаборатория физики Больших энергий

Краков, Польша

Сделан анализ 90 струй сверхвысокой энергии ($E_{pc} \geq 10^{12}$ эв) с $5 \leq n_s \leq 20$ и с ограниченным числом треков испарения ($N_h \leq 5$), для сравнения углового распределения вторичных частиц с квази-прямоугольным распределением, предсказанным модифицированной статистической моделью с независимой эмиссией частиц.

Получено значительное отклонение наблюдаемых угловых распределений от квази-прямоугольной формы, которое согласуется с предсказанием двухцентровой модели.

A COMPARISON OF ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES OF ULTRA-HIGH ENERGY JETS WITH THE QUASI-RECTANGULAR DISTRIBUTIONS

J.Babecki and M.Miesowicz

Institute of Nuclear Research, Laboratory of High Energy Physics, Krakow, Poland

90 ultra-high energy jets ($E_p \gtrsim 10^{12}$ eV) with $5 \leq n_s \leq 20$ and limited number of evaporation tracks ($N_h \leq 5$), have been analysed in order to compare the angular distributions of secondary particles with the quasi-rectangular angular distribution predicted by a modified statistical model with independent emission of particles. The analysis has shown a very significant deviation of the observed angular distributions from the quasi-rectangular form. The deviation is of the type predicted by the fire-ball model.

ANALYSIS OF COSMIC RAY JETS ON THE BASIS OF THE LINKED HEAVY PARTICLE MODEL

T.Kobayashi, M.Namiki, I.Ohba and S.Orito
Waseda University, Tokyo, Japan

Recent experiments of cosmic ray jets are analyzed on the basis of the linked heavy particle model proposed by some of the present authors. The model should be regarded as an attempt along the lines of throught that the inner heavy boson and/or $N\bar{N}$ pair clouds of colliding nucleons are mainly responsible for the multiple particle production in NN collisions at very high energies. From the ICEF data, the total energy of charged secondaries n_s, and the four momentum transfer Δ are obtained, which yield the n_s vs. E_{ch} and Δ vs. E_{ch} plots. It is clarified that the wide fluctuation of the n_s vs. E_{ch} plot can be successfully parametrized by Δ, and that the fluctuation can be reproduced from the formula of the model substituted by the values of the Δ vs. E_{ch} plot. This means the experiments to be consistent with the linked heavy particle model. It is seen from the Δ vs. E_{ch} plot that the mean value of Δ is of the order of magnitude of the nucleon mass irrespective of E_{ch}, while the fluctuation of Δ around its mean value becomes large with increasing E_{ch}. Finally, with the expectation obtaining an information about final state of produced bosons, the remarks are made on the correlation between the mean variance of the multiplicity δn_s and the average multiplicity $\langle n_s \rangle$.

SEMI-CLASSICAL BOSON WAVE EXCITATION IN INELASTIC COLLISIONS AND SHADOW SCATTERINGS AT VERY HIGH ENERGIES

Mikio Namiki
Department of Applied Physics, and Science and Engineering Research Laboratory, Waseda University, Tokyo, Japan

Under the assumption that most of elastic scatterings at very high energies are the shadow scatterings of the inelastic collisions resulting in excitation of the semi-classical heavy boson wave, the interrelationship between the elastic scattering and the multiple particle production phenomena at very high energies is investigated. First, some specific properties of the semi-classical boson wave state are discussed. Next, the characteristic parameter of the diffraction pattern in the elastic scattering is written in terms of the semi-classical boson wave. On this basis, it is shown that recent observations of cosmic ray jets are consistent with elastic scattering data, and, in particular, that the distribution of the invariant momentum transfer in the multiple particle production is well understood within the framework of the present theory.

ФЕНОМЕНОЛОГИЧЕСКАЯ КАРТИНА ГЕНЕРАЦИИ ВТОРИЧНЫХ ЧАСТИЦ ВО ВЗАИМОДЕЙСТВИЯХ НУКЛОНОВ ПРИ ЭНЕРГИЯХ В СОТНИ БЭВ

Н.А.Добротин, Н.Г.Зелевинская, К.А.Котельников, В.М.Максименко, В.С.Пучков, С.А. Славатинский, Ю.А.Смородин

Физический институт им. П.Н.Лебедева

Москва, СССР

Анализ экспериментальных данных о нуклонных взаимодействиях при энергиях в сотни Бэв приводит к представлению о том, что мезоны в большинстве взаимодействий генерируются за счет двух различных процессов:

I. Основная часть мезонов образуется в результате распада одного или нескольких мезонных сгустков (*fire ball'ов*), движущихся в системе центра масс со скоростями, много меньшими, чем скорость барионов после взаимодействия; угловое распределение мезонов в системе *fire ball'а* является изотропным, а энергетический спектр их не зависит от первичной энергии и аппроксимируется формулой Планка при температуре $T \simeq 0{,}7\,\mu_\pi$;

2. Небольшое число вторичных мезонов наиболее высоких энергий (всего в несколько раз меньших, чем энергия первичного нуклона) возникает в результате распада возбужденных состояний нуклонов, образующихся во взаимодействии; при этом, по-видимому, существенен вклад высоких изобарных уровней. Изобарный процесс генерации π-мезонов можно рассматривать как источник основной доли μ-мезонов и γ - квантов высокой энергии в атмосфере.

Полный коэффициент неупругости при взаимодействиях нуклонов остается приблизительно постоянным в широком интервале энергий взаимодействующих нуклонов.

Y-14

PHENOMENOLOGICAL PICTURE OF SECONDARY PARTICLES PRODUCTION IN NUCLEON INTERACTIONS AT ENERGIES OF HUNDREDS OF GeV

N.A.Dobrotin, N.G.Zelevinskaya, K.A.Kotelnikov, V.M.Maximenko, V.S.Puchkov, S.A.Slavatinsky, Yu.A.Smorodin

P.N.Lebedev Physical Institute, Moscow, USSR

Analysis of experimental data on nucleons interactions at energies of hundreds of GeV leads to a conclusion that in the majority of interactions the mesons are produced through two different processes:

1. The main part of mesons results through decay of one or several fire balls. Fire balls moves in c.m. system with velocities much less, than baryons velocity after interaction. Angular distribution of mesons in fire ball's system is isotopic. Momenta distribution of these mesons is independent of primary energy and can be approximated by Plank's function at temperature $T \approx 0.7\,\mu_\pi$.

2. A small number of secondary mesons with the highest energies (only several times less than primary nucleon energy) results through decay of exited states of nucleons, produced in interactions; apparently, contribution of high isobaric states is essential. Isobaric process of π - mesons production can be considered as source of main part of cosmic rays μ-mesons and high energy γ - quanta in the atmosphere.

Total inelasticity coefficient of nucleon interactions remains more or less constant in the wide energy region.

У-15

НЕКОТОРЫЕ ХАРАКТЕРИСТИКИ ВЗАИМОДЕЙСТВИЯ НУКЛОНОВ С АТОМНЫМИ ЯДРАМИ

А.М.Лебедев ,С.А.Славатинский,
Б.В. Толкачев

Физический институт им. П.Н.Лебедева

Москва, СССР

На основе оптической модели ядра рассчитаны величины сечений неупругого взаимодействия нуклонов с атомными ядрами. Распределение нуклонов в ядрах взято из опытов по рассеянию электронов. Найденная зависимость сечений от атомного веса ядра мишени $\sigma = \sigma_0 A^{3/4}$ где $\sigma_0 = 33$ мбн хорошо согласуется с экспериментальными данными для энергий 25 Бэв.

Исходя из представлений о последовательных взаимодействиях первичного нуклона с нуклонами ядра, вычислена кратность соударений для различных ядер, а также доля энергии, сохраняемая нуклоном после взаимодействия. Результаты вычислений сопоставлены с экспериментальными данными для энергий 25 Бэв.

Исходя из представлений о последовательных взаимодействиях первичного нуклона с нуклонами ядра, вычислена кратность соударений для различных ядер, а также доля энергии, сохраняемая нуклоном после взаимодействия. Результаты вычислений сопоставлены с экспериментальными данными.

SOME CHARACTERISTICS OF INTERACTIONS OF NUCLEONS WITH ATOMIC NUCLEI

A.M.Lebedev, S.A.Slavatinsky, B.V.Tolkachev

P.N.Lebedev Physical Institute, Moscow, USSR

The cross sections of inelastic nucleon-nuclei interactions were calculated on the ground of the optical nucleus model. The distribution of nucleons in nuclei was taken from electron scattering experiments.

The cross section dependence on the nucleus atomic weight was found to be $\sigma = \sigma_0 A^{1/3}$ where $\sigma_0 \approx 33$ mb. This dependence is in a good agreement with experimental data in the energy region at 25 GeV.

Plurality of collisions for different nuclei and the fraction of energy conserved by nucleon after interaction were calculated under assumption of successive interactions of primary nucleon with nucleons in nucleus. The results of calculations are compared with experimental data.

У-I6

АНАЛИЗ ДАННЫХ УПРУГОГО РАССЕЯНИЯ ТИПА π^--p, π^+-p, и K^+-p ПРИ ВЫСОКИХ ЭНЕРГИЯХ

А.Френкель, Ш.Красновски, Д.Пинтер

Центральный институт физических исследований Венгерской Академии наук

Мы исследовали данные упругого рассеяния между импульсами 7 и I7 Бэв/с с использованием точных формул амплитуд упругого рассеяния для одного полюса Редже, опубликованных автором А.Л.Рид и его соавторами /2/. Мы сделали заключение, что приближение одним полюсом Редже не соответствует экспериментальным данным. Также было показано, что экспериментальные данные трудно передать и приближением нескольких полюсов Редже.

AN ANALYSIS OF THE HIGH ENERGY π^-p, π^+p AND K^+p ELASTIC SCATTERING DATA

A.Frenkel, S.Krasznovsky, G.Pinter
Central Research Institute for Physics of the Hungarian Academy of Sciences

We have examined π^-p, π^+p and K^+p elastic scattering data between 7 and 17 GeV/c using the exact expression for the one Regge pole contribution of scattering amplitude published by A.L.Read et al. [2]. We may conclude, that the one Regge pole approximation is definitely inconsistent with the experimental data. It was also shown that the experimental data can be hardly explained by using the many Regge pole approximation too.

V-I7

УПРУГОЕ РАССЕЯНИЕ БЫСТРЫХ ЧАСТИЦ В ОБЛАСТИ ОЧЕНЬ МАЛЫХ УГЛОВ

В.С. Барашенков

Объединенный институт ядерных исследований

Лаборатория теоретической физики

Dubna

Краткое сообщение в доклад репортера. Сравнение вычисленной на электронной машине действительной части амплитуды упругого $\pi^{\pm} - p$, $p - p$ и $p - \bar{p}$ рассеяния под кривым углом с экспериментальными данными при энергиях $T \gtrsim 1$ Гэв показывает, что в настоящее время нет никаких указаний на нарушение дисперсионных соотношений вплоть до расстояний 5.10^{-15} см.

V-I7

ELASTIC SCATTERING OF FAST PARTICLES IN THE REGION OF VERY SMALL ANGLES

V.S. Barashenkov

Joint Institute for Nuclear Research
Laboratory of Theoretical Physics
Dubna

A brief communication is contributed to the paper of the reporter. Comparision between the real part of the elastic $\pi^{\pm} - p$, p - p and $\bar{p}$ - p scattering amplitude at zero angle calculated with the electronic computer and experimental data at an energy $T \geqslant$ I GeV shows that at present there is no evidence for the violation of dispersion relations up to 5.10^{-15} cm.

V-I8

ОПРЕДЕЛЕНИЕ ВЕЩЕСТВЕННОЙ ЧАСТИ АМПЛИТУДЫ p-p РАССЕЯНИЯ ВПЕРЕД ПРИ ЭНЕРГИИ ПРОТОНОВ $>$ БЭВ НА ОСНОВЕ ДИСПЕРСИОННЫХ СООТНОШЕНИЙ ДЛЯ $p,\tilde{p}-p$.

И.И.Левинтов, Г.М.Адельсон-Вельский

Институт теоретической и экспериментальной физики,
Москва, СССР.

На основе дисперсионных соотношений с двумя вычитаниями для усредненной по спинам амплитуды рассеяния $p,\tilde{p}-p$ вперед ($A_{p,\tilde{p}-p}^{(t=0)}$) определяются значения вещественной части амплитуды $p-p$ рассеяния в области импульсов $>$ 2 Бэв/с. Результаты сравниваются с существующими экспериментальными данными о превышении $(d\sigma/dt)_{t=0}$ над оптическим пределом. Делаются выводы о поведении спин-спиновых частей p-p амплитуды при высоких энергиях.

Оценка вклада от интеграла по ненаблюдаемой области энергий проводится с использованием надежных экспериментальных данных по вещественным частям $p-p$ амплитуды рассеяния вперед при $p<$ IБэв/с. Полученные значения нефизического интеграла экстраполируются с ограниченной погрешностью в область высоких энергий на основе предположения о положительной определенности $Im\, A_{p\tilde{p}}(u, t=0)$ при $4p^2 < u < 4M^2$.

DETERMINATION OF THE REAL PART OF p-p SCATTERING AMPLITUDE AT THE PROTONS ENERGY > BeV BASING ON THE DISPERSION RELATIONS FOR $p, \tilde{p} - p$

I.I. Levintov, G.M. Adelson-Velsky

Institute for Theoretical and Experimental Physics, Moscow, USSR

Basing on the dispersion relations with two subtractions for the spin averaged amplitude of $p\tilde{p}$-p forward scattering ($A_{p\tilde{p}-p}^{(t=0)}$) the values of the real part of pp-scattering are determined in the region of the momenta > 2 BeV/c. The results are compared with the experimental data on the excess of $(d\sigma/dt)_{t=0}$ over the optical limit. The conclusions about the behaviour of spin-spin parts of p-p amplitude at high energies are made.

The contribution from the integral over the unphysical region of the energies is estimated using the reliable experimental data on the real parts of p-p forward scattering at p < I BeV/c. The unphysical integral values obtained are extrapolated with the limited errors into the high energies region assuming the positive definiteness of $Im A_{p\tilde{p}}(u, t=0)$ at $4p^2 < u < 4M^2$.

У-I9

РЕШЕНИЕ ЗАДАЧИ МНОГОКРАТНОГО РАССЕЯНИЯ ПО МЕТОДУ ПЕРЕВАЛА

Л.Г. Заставенко, А. Чилок

Объединенный институт ядерных исследований
Дубна

Существующие методы позволяют получить решение задачи многократного рассеяния а) в области малых углов (теория Мольера) и б) в области больших углов (где основную роль играет однократное рассеяние). В работе предложен метод, который как предполагается, дает решение при всех углах. Приводятся результаты численного расчета, подтверждающие надежность метода.

SADDLE POINT APPROXIMATION FOR THE SOLUTION OF MULTIPLE SCATTERING TRANSPORT EQUATION

L.G.Zastavenko and A.Chilok

Joint Institute for Nuclear Research
Dubna, USSR

The existing methods yield the solution of the multiple scattering transport equation only for the cases of a) small angles, where works Moliere theory and b) large angles, where multiple scattering does not play dominant role. The proposed method, on the contrary seems to be valid, for all angles. There are given the results of numerical calculation, affirming the validity of the method.

TOTAL CROSS SECTIONS AND DIFFRACTION SCATTERING IN THE 10-100 GeV RANGE ACCORDING TO THE STRIP APPROXIMATION

Geoffrey F. Chew and Vigdor L. Teplitz

Department of Physics and Lawrence Radiation Laboratory
University of California, Berkeley, California

Preliminary results from dynamical calculations based on the strip approximation are reported, supporting the conjecture that small momentum-transfer scattering amplitudes in the 10-100 GeV range can be theoretically predicted from an understanding of the masses and widths of bound states and resonances. Given the mass and width of the and the mass of the f^0, the Regge pole representation leads to a satisfactory prediction for the total cross section and diffraction peak width at high energy.

УП

ПИОННЫЕ РЕЗОНАНСЫ

Эксперимент

PION RESONANCES

Experimental

УП-I

ИЗУЧЕНИЕ РЕАКЦИИ $\pi^- + p \to 2\pi^- + 2\pi^+ + K\pi^0 + n$ ПРИ ИМПУЛЬСЕ ПЕРВИЧНЫХ π МЕЗОНОВ 3,5 Бэв/с.

Институт теоретической и экспериментальной физики

Айнутдинов П.С., Замбовский С.П., Селектор Я.М., Суляченко В.П.

С помощью жидководородной пузырьковой камеры ϕ 25 см изучалась реакция $\pi^- + p \to 2\pi^- + 2\pi^+ + K\pi^0 + n$ при импульсе первичных π^- -мезонов 3,5 $\frac{Bev}{c}$.

В распределении по эффективным массам 4-х заряженных π -мезонов наблюдается пик при энергии ~ I250 *Mev*.

В распределении по недостающим массам к 4-м заряженным π -мезонам из области пика наблюдается максимум в районе N 3/2, 3/2 - изобары.

STUDY OF THE REACTION $\pi^- + p \to 2\pi^- + 2\pi^+ + k\pi^0 + n$ AT 3.5 GeV/c PRIMARY MESON MOMENTUM

Ainutdinov P.S., Zambovski S.P., Selektor Ya.M.,
Sulyachenko V.P.

Institute of Theoretical and Experimental Physics, Moscow, USSR

Using hydrogen bubble Ø 25 cm reaction $\pi^- + p \to 2\pi^- + 2\pi^+ + k\pi^0 + n$ at incident momenta 3.5 BeV/c has been studied. The effective-mass distribution of four charged mesons shows a peak at 1250 MeV. The distribution of missing mass to four charged mesons with effective mass in the peak region shows a peak in the region of $N_{3/2, 3/2}$.

УП-2

ИССЛЕДОВАНИЕ РЕАКЦИИ $\pi^- + p \to p + \pi^- + \pi^- + \pi^+$ ПРИ ИМПУЛЬСЕ -2.7 БЭВ/С

И.А.Ветлицкий, В.В.Владимирский,
В.К.Григорьев, А.П.Гришин, В.М.Гужавин,
Г.К.Клигер, В.З.Колганов, А.В.Лебедев,
Г.С.Ломкаци, В.Т.Смолянкин, А.П.Соколов,
Е.А.Сысоев

Институт теоретической и экспериментальной
физики, Москва, СССР

С помощью 55 см.жидководородной камеры исследовалось распределение по эффективным массам 3-х π - мезонов, образованных в реакции $\pi^- + p \to p + \pi^- + \pi^- + \pi^+$ при первичном импульсе 2.7 Бэв/С. Отбирались случаи с малым переданным протону импульсом.

INVESTIGATION OF REACTION $\pi^- + p \rightarrow p + \pi^- + \pi^- + \pi^+$ AT A MOMENTUM OF 2.7 BeV/c

I.A.Vetlitsky, V.V.Vladimirsky, V.K.Grigoriev, A.P.Grishin, V.M.Guzhavin, O.K.Kliger, V.Z.Kolganov, A.V.Lebedev, G.S.Lomkazi, V.T.Smolyankin, A.P.Sokolov, E.A.Sisoev

Institute of Theoretical and Experimental Physics, Moscow, USSR

By means of 55 cm liquid-hydrogen bubble chamber the distribution of $\pi^-\pi^-\pi^+$ effective-mass in the reaction $\pi^- + p \rightarrow p + \pi^- + \pi^- + \pi^+$ at a momentum of 2.7 BeV/c was examinated. The events with a little momentum transfer to proton was selected.

УП-3

РАДИАЦИОННЫЕ РАСПАДЫ РЕЗОНАНСОВ И ПОИСКИ ПАРНОГО РОЖДЕНИЯ РЕЗОНАНСОВ

Ю.А.Будагов, А.Г.Володько, В.П.Джелепов,
В.Г.Иванов, В.С.Кладницкий, Ю.Ф.Ломакин,
И.Паточка, В.Б.Флягин, П.В.Шляпников

Объединенный институт ядерных исследований
Лаборатория ядерных проблем

Произведена обработка фотографий, полученных на метровой пропановой камере в магнитном поле 17000 эрст. на пучке π^- -мезонов 5 Гэв/с .

Получены предварительные данные о рождении η - мезона, распадающегося на 2 γ -кванта, о радиационных распадах других резонансов и о парном рождении резонансов.

YII-3

RESONANCE RADIATIVE DECAYS AND SEARCH FOR PAIR RESONANCE PRODUCTION

Yu.A.Budagov, V.P.Dzhelepov, V.B.Flyagin, V.G.Ivanov, V.S.Kladnitsky, Yu.F.Lomakin, J.Patočka, P.V.Shlyapnikov, A.G.Volodko

Joint Institute for Nuclear Research
Laboratory of Nuclear Problems
Dubna

Pictures obtained with a 1-meter propane bubble chamber in the 17,000 Oe magnetic field with a 5 GeV/c pion beam have been treated.

The preliminary data on the production of the η-meson decaying into two γ-quanta and the radiative decays of other resonances and on pair resonance production have been obtained.

УП-4

ИССЛЕДОВАНИЕ СПЕКТРОВ ГАММА-КВАНТОВ ПРИ $\pi^- p$ - ВЗАИМОДЕЙСТВИИ

В.С.Пантуев, М.Н.Хачатурян

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Методикой черенковских спектрометров полного поглощения в сочетании с искровыми камерами изучены спектры гамма-квантов, образующихся в результате взаимодействия пи-минус мезонов с водородом. Рассматриваются вероятности распадов резонансных частиц на два гамма-кванта или на пи-нуль мезон и гамма-квант в интервале энергий от I Гэв до 7 Гэв.

AN INVESTIGATION OF GAMMA-RAYS SPECTRA IN $\pi^- p$ INTERACTION

V.S.Pantujev, M.N.Khachaturian

Joint Institute for Nuclear Research

By means of the total absorption Cerenkov spectrometer together with spark chambers the spectra of protons, produced in π^- - proton interactions have been studied. Two proton and photon - π^0 - meson decay probabilities of resonances formed in the energy range 1 - 7 GeV are considered.

УП-5

ИССЛЕДОВАНИЕ РОЖДЕНИЯ ЗАРЯЖЕННЫХ ρ МЕЗОНОВ πp МЕЗОНАМИ НА ПРОТОНЕ

И.А.Радкевич, В.В.Соколовский, В.В.Владимирский, В.Н.Лузин, Ю.Ф.Томащук, А.М.Благородов, Л.И.Мурза, Т.Г.Смолянкина, А.А.Панов

Будут представлены результаты исследования реакций $\pi^{\pm} + p \to p + \rho^{\pm}$ с помощью искровых камер. Предполагается получить отношение сечений рождения ρ^{+} и ρ^{-} мезонов при нескольких значениях энергий первичного пучка в области образования тяжелых изобар с массами 2,2 и 2,35 Бэв/$с^2$.

INVESTIGATION OF CHARGED ρ-MESONS PRODUCTION IN πp INTERACTIONS

A.M.Blagorodob, V.N.Luzon, L.I.Moorsar, A.A.Panov,
I.A.Radkevich, T.G.Smolyankina, V.V.Sokolovsky,
Yu.F.Tomaschik, V.V.Vladimirovsky

Results of $\pi^{\pm} + p \to p + \rho^{\pm}$ reactions investigations using spark chambers are presented. The ratio of ρ^{+} and ρ^{-} meson production cross sections is supposed to obtain at several values of the energies of the initial beam in the region of heavy isobar production with the masses 2.2 and 2.35 BeV/ c^2.

УП-6

ФОТОРОЖДЕНИЕ η - МЕЗОНОВ НА ЯДРАХ ПРИ ЭНЕРГИЯХ 600 МЭВ

Ю.А.Александров, В.Н.Майков,
А.В.Куценко, В.В.Павловская

Физический институт им.П.Н.Лебедева
АН СССР

Сообщаются результаты исследования углового распределения η - мезонов, рождаемых γ - квантами с энергией 600 Мэв на ядрах.

THE η - MESON PHOTOPRODUCTION ON NUCLEI AT THE ENERGY 600 MeV

Yu.A.Alexandrov, V.N.Maikov, A.V.Kutzenko,
V.V.Pavlovskaja
P.N.Lebedev Physical Institute of the Academy of Science of the USSR

The Results of the experimental investigation of the angular distribution of η - meson produced by 600 MeV photons on nuclei will be reported.

УП-7

ИССЛЕДОВАНИЕ РАДИАЦИОННЫХ РАСПАДОВ РЕЗОНАНСОВ

А.И.Алиханов, Г.Л.Баятян, Э.В.Брахман,
Ю.В.Галактионов, Г.П.Елисеев,
О.Я.Зельдович, Л.Г.Ландсберг,
В.А.Любимов, Ф.А.Павловский

Институт теоретической и экспериментальной физики,
Москва, СССР

Изучается реакция $\pi^- + p \to X^0 +$ нейтральные.

π^- - мезон с импульсом 1,0 ÷ 2,0 *Бэв/с* взаимодействует в мишени, за которой расположены счетчики антисовпадений, γ - кванты из мишени, пройдя счетчики антисовпадений, конвертируют в свинце и образующиеся e^+e^- - пары регистрируются 4-мя сцинтилляционными счетчиками, включенными попарно. Непосредственно за счетчиками установлены искровые камеры (2 промежутка по 15 см), в которых наблюдаются треки от e^+e^- - пар. Камеры находятся в магнитном поле (12 *Кгс*), по фотографиям в камерах измеряются все импульсы и углы частиц, участвующих в реакции и восстанавливается полная кинематика реакций $\pi^- + p \to \pi^0 + n$ (1), $\pi^- + p \to \underset{\hookrightarrow 2\gamma}{\pi^0} + n$ (2). Геометрия опыта такова, что реакция (1) подавляется в пользу реакции (2). Изучается зависимость сечения реакции $\pi^+ + p \to \underset{\hookrightarrow 2\gamma}{\pi^0} + n$ от энергии первичного пучка π^- - мезонов. Измерения продолжаются.

INVESTIGATION OF RESONANCES RADIATION DECAYS

A.I.Alikhanov, G.L.Bayatyan, E.V.Brakhman, Yu.V.Galaktionov, L.G.Landsberg, V.A.Lyubimov, F.A.Pavlovsky, C.P.Yeliseev, O.Ya.Zeldovich

Institute for Theoretical and Experimental Physics, Moscow, USSR

The reaction $\pi^- + p \to \underset{\hookrightarrow 2\gamma}{\chi^0} +$ neutral is investigated. π^- - meson with the momentum 1.0 ÷ 2.0 BeV/c interacts in the target behind which the anticoincidence counters are placed. γ - quanta from the target passing the anticoincidence counters convert in the lead and e^+e^- pairs generated are registered by the four scintillation counters included in pair coincidences. Directly behind the counters the spark chambers are placed (two 15 cm gaps) in which the tracks of e^+e^- - pairs are observed. The chambers are in a magnetic field (12 кгс) . From the chambers photographs all the momenta and the angles of the particles participating in the reaction are measured and the total kinematics of the reactions $\pi^- + p \to \pi^0 + n$ (1) $\pi^- + p \to \underset{\hookrightarrow 2\gamma}{\eta^0} + n$ (2) is reproduced. The geometry of the experiment allows to suppress the reaction (1) in favour of the reaction (2). The dependence of the reaction $\pi^- + p \to \underset{\hookrightarrow 2\gamma}{\eta^0} + n$ cross section on the energy of the π^- meson initial beam is investigated. The measurements are in progress.

УП-8

ИССЛЕДОВАНИЕ РАДИАЦИОННЫХ РАСПАДОВ РЕЗОНАНСОВ И АНАЛИЗ РЕАКЦИЙ С РОЖДЕНИЕМ НЕСКОЛЬКИХ Π^0 -МЕЗОНОВ

В.Г.Гришин, Д.К.Копылова, В.Б.Любимов, Му Цзюнь, М.И.Подгорецкий, Л.В.Сильвестров, М.Спыркез, В.Н.Стрельцов

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

В работе использовалась 24-литровая пропановая пузырьковая камера, помещенная в пучок Π^- -мезонов с импульсом 4,0 Гэв/с. При просмотре фиксировались 0,2-х и 4-х лучевые события, сопровождающиеся испусканием одного или больше γ - квантов. Анализ таких случаев позволил получить оценки сечений радиационных распадов известных резонансов. Специальное внимание было обращено на возможность выделения и анализа взаимодействий первичных Π^- -мезонов со свободным протоном с образованием двух нейтральных частиц (двух Π^0 -мезонов, Π^0 -мезона и нейтрона и т.д.). В работе также произведена оценка сечения перезарядки.

INVESTIGATION OF RADIATIVE DECAYS OF RESONANCES AND THE ANALYSIS OF INTERACTIONS WITH π^0- MESON PRODUCTION

V.G.Grishin, D.K.Kopylova, V.B.Lyubimov, Mu Tsiun,
M.J.Podgoretski, L.V.Silvestrov, M.Spitchez, V.N.Streltsov

Joint Institute for Nuclear Research
Dubna, USSR

The present work was done in the bubble chamber, exposed to a π^-- mesons beam of 4.0 GeV/c. In scanning zero-two- and four-prong events accompanied by one or more γ- quanta were selected. The analysis of such events allowed the evaluation of the cross section for radiative decays of known resonances. Special attention was given to the selection and the analysis of incident π^- meson interactions with free protons in which two neutral particles appeared (two π^0 mesons, a π^0 meson and a neutron, etc.). The evaluation of charge-exchange cross section was also made.

УП-9

НЕУПРУГИЕ Π^-p - ВЗАИМОДЕЙСТВИЯ ПРИ ЭНЕРГИИ ПИОНОВ 7,5 ГЭВ

В.А.Беляков, Е.Н.Кладницкая, И.Курелару, Е.С.Соколова

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

Э.Баля, О.Баля, В.Балинт, И.Макарович, А.Михул, Д.Мумуяну, Т.Понта, К.Поточану, М.Сабэу

Институт атомной физики, г.Бухарест
Лаборатория высоких энергий

На фотографиях, полученных с помощью 24-литровой пропановой пузырьковой камеры ЛВЭ изучались 4-х лучевые события от Π^-p - взаимодействий с импульсом 7,5 Гэв/с. Построены импульсные и угловые распределения пионов и протонов из этих взаимодействий. Рассчитаны спектры эффективных масс для 2П-, 3П- и 4П-систем, а также систем из протона и пионов: рП, р2П, р3П. Обсуждаются угловые и импульсные спектры и распределения эффективных масс. Оценено среднее число Π^0 -мезонов на одно взаимодействие на основе числа γ - квантов и кинематики процессов.

$\pi^- p$ - INELASTIC INTERACTIONS AT 7.5 GeV/c

V.A.Belyakov , E.N.Kladnitskaya, I.Curelaru,
E.S.Sokolova
Joint Institute for Nuclear Research
Dubna, USSR

E.Balea, O.Balea, V.Balint, I.Macarovitsch,
A.Mihul, D.Mumuianu, T.Ponta, C.Potoceanu,
M.Sabau

Institute for Atomic Physics, Bucarest
Rumania

Studies of 4-prong $\pi^- p$-interactions in the propan 24 litre bubble chamber of L.H.E. at 7.5 GeV/c incident π^- - mesons are reported. Angular and momentum distributions of pions and protons are presented, as well as effective mass spectra for pion system ($2\pi^-$, $3\pi^-$, $4\pi^-$) and for pion-proton system ($p\pi^-$, $p2\pi^-$, $p3\pi^-$). A discussion of these distributions and effective mass spectra is presented. On the basis of the kinematical analysis and of the number of detected γ-quanta, the mean number of π^0 per interaction is evaluated.

RADIATION DECAYS OF NEUTRAL RESONANCE PARTICLES INVESTIGATION

I.M.Gramenitskij, T.Kanarek, A.S.Martynov, B.Niczyporukh
G.Semashko, L.A.Tichonova

Joint Institute for Nuclear Research, Dubna, USSR

The radiation decay modes of neutral resonance particles (ω^0, η^0 and others) have been investigated at the films of 24-liter Xe-bubble chamber exposed to 9 GeV/c π^- - beam.

For this purpose 80000 pictures were scanned and 800 (π^--Xe) events, correlated to 3- γ-rays, which converted in the fiducial volume of the chamber were found.

For every event the angles between incident π^--mesons and each gamma-quantum have been measured and the energy of gamma-rays has been determined by the method proposed in /I/.

The distributions of effective masses for 2 gamma and 3 gamma rays have been done.

The study of the obtained distributions permits to estimate the fraction of $\eta^0 \to$ 2 gammas and $\omega^0 \to \pi^0$ + gamma decays in the selected class of events.

/I/ J.Danysz, Z.Strugalski, O.Czyzewski. Preprint P-1144,Dubna, 1964.

УП-II

ХАРАКТЕРНЫЕ ОСОБЕННОСТИ ОБРАЗОВАНИЯ ω, χ И ρ МЕЗОНОВ В πN И NN СТОЛКНОВЕНИЯХ ПРИ ВЫСОКОЙ И СВЕРХВЫСОКОЙ ЭНЕРГИИ

В.А.Беляков и Э.Г.Бубелев

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Проведено сравнение характерных особенностей образования ω, χ и ρ - мезонов в NN столкновениях с энергией в несколько Тэв (10^3 Гэв), обнаруженного одним из авторов, и в Π - N столкновениях с энергией в несколько Гэв. Показана возможность интерпретации сходных особенностей с единой точки зрения. Рассмотрены вытекающие отсюда следствия, в частности, величина коэффициента неупругости нуклонов.

CHARACTERISTIC FEATURES OF THE ω, χ AND ρ PRODUCTION IN NN AND πN COLLISIONS AT SUPERHIGH AND HIGH ENERGIES

V.A.Belyakov, E.G.Bubelev

Joint Institute for Nuclear Research,
Dubna, USSR

The characteristic features of the ω, χ and ρ production in Tev NN collisions, observed previously by one of the authors, are compared with thouse in GeV πN collisions. The possibility of interpretation of these features is discussed from a single point of view. Certain consequences are considered, particulary the value of the inelasticity coefficient of nucleons.

УП-I2

АНАЛИЗ РЕАКЦИЙ ПРИ ВЫСОКИХ ЭНЕРГИЯХ С ПОМОЩЬЮ ГРАФИЧЕСКИХ МЕТОДОВ КИНЕМАТИКИ

Э.Г.Бубелев

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

Рассмотрены основные принципы анализа реакций при высоких энергиях с помощью известных графических методов, основанных на различных отображениях пространства скоростей Лобачевского-Эйнштейна в евклидово пространство. Благодаря своей наглядности эти методы существенно облегчают определение типа реакции и его количественных характеристик в каждом отдельном случае. С помощью этих методов получены новые физические результаты, в частности, в струях высокой энергии обнаружены ρ и ω мезоны с энергией в несколько Тэв (10^3 Гэв).

THE ANALYSIS OF THE HIGH ENERGY REACTIONS USING GRAPHIC METHODS OF KINEMATICS

E.G.Bubelev

Joint Institute for Nuclear Research
Dubna, USSR

The basic principles of the analysis of the high energy reactions using known graphic methods are considered. These methods are based on the different mappings of the Lobachevsky--Einstein velocity- space into the euclidean space. Owing to their visualities these methods facilitate essentially the determination of the type of the reaction and its numerical characters in each separate event. New physical results are obtained using these methods, particularly ρ and ω -mesons with the energy 1 ÷ 3 TeV (10^3 GeV) are found in the high energy jets.

УП-I3

П - МЕЗОННЫЕ РЕЗОНАНСЫ, РОЖДЕННЫЕ СО СТРАННЫМИ ЧАСТИЦАМИ В π^-p -ВЗАИМОДЕЙСТВИЯХ ПРИ 7,5 Гэв/с

В.А.Беляков, В.И.Векслер, Н.М.Вирясов,
Е.Н.Кладницкая, Г.И.Копылов, А.Михул,
В.Н.Пенев, Е.С.Соколова, М.И.Соловьев

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Исследовались П - мезонные резонансы, образующиеся совместно со странными частицами. Обнаружено рождение ρ - мезонов совместно с Λ К-парами в событиях с множественностью заряженных частиц $n_s = 4$, с сечением $\sigma_\rho = (20 \pm 8)$ мкбарн. Приводятся оценки рождения ω - и η - резонансов. Обсуждается пик в распределении эффективных масс четырех пионов в области I340 Мэв.

PION RESONANCES PRODUCED TOGETHER WITH STRANGE PARTICLES IN π^--p INTERACTIONS AT 7.5 GeV/c

V.A.Belyakov, V.I.Veksler, N.M.Viryasov,
E.N.Kladnitskaya, G.I.Kopylov, A.Mihul, V.N.Penev,
E.S.Sokolova, M.I.Soloviev

Joint Institute for Nuclear Research
Dubna, USSR

The pion resonances produced together with strange particles have been investigated. It was found that the ρ-meson is produced together with ΛK - pairs in the events with the multiplicity of charged particles $n_s = 4$. The cross section for such production σ_ρ is equal to (20 ± 8) μb. The estimates for ω and η resonance production are given. The peak in the energy region of 1340 MeV is discussed.

K^+p Interactions at 5.0 GeV/c

S. P. Almeida, H. W. Atherton, T. A. Byer, P. J. Dornan, A. G. Forson, J. H. Scharenguivel, D. M. Sendall, B. A. Westwood.

Cambridge University, Cavendish Laboratory, England

The 81 cm Saclay hydrogen bubble chamber has been exposed to a separated K^+ beam of 5.0 GeV/c incident momentum. The reaction $K^+ + p \rightarrow K^+ + p + \pi^+ + \pi^-$ is being studied and the results obtained from a preliminary analysis of about 700 events are presented.

Some production and decay properties of observed resonances are discussed.

УП-I5

ИССЛЕДОВАНИЕ РЕАКЦИИ $\pi^- + p \to p + \pi^+ + \pi^- + \pi^-$ ПРИ ИМПУЛЬСЕ 4,8 БЭВ/С

И.А.Ветлицкий, В.М.Гулавин, Г.К.Клигер,
В.В.Колганов, А.В.Лебедев, Г.С.Ломкаци,
В.Т.Смолянкин, А.П.Соколов, Е.А. Сысоев

Институт теоретической и экспериментальной физики
Москва, СССР

С помощью 55 см. жидководородной пузырьковой камеры исследовалось распределение по эффективным массам 3-х π -мезонов, образованных в реакции $\pi^- + p \to p + \pi^+ + \pi^- + \pi^-$ при первичном импульсе 4.8 Бэв/с. Отбирались случаи с малым переданным протону импульсом.

YII-15

INVESTIGATION OF REACTION $\pi^- + p \to p + \pi^- + \pi^- + \pi^+$ at A MOMENTUM OF 4.8 BeV/c

I.A. Vetlitsky, V.M.Gushavin, G.K.Kliger,
V.Z.Kolganov, A.V.Lebedev, G.S.Lomkazi,
V.T.Smolyankin, A.P.Sokolov, E.A.Sisoev

Institute of Theoretical and Experimental Physics,
Moscow, USSR

By means of 55 sm liquid-hydrogen bubble chamber the distribution of $\pi^-\pi^-\pi^+$ effective-mass in the reaction $\pi^- + p \to p + \pi^- + \pi^- + \pi^+$ at a momentum of 4.8 BeV/c was examinated. The events with a little momentum transfer to proton was selected.

УП-I6

ИССЛЕДОВАНИЕ ПАР $K\bar{K}$, ГЕНЕРИРОВАННЫХ π^--МЕЗОНАМИ С ИМПУЛЬСОМ 2,8 *Бэв/с*

В.В.Бармин, А.Г.Долголенко, И.А.Ерофеев,
Ю.С.Крестников, А.Г.Мешковский,
Г.Д.Тихомиров, Ю.В.Требуховский,
В.А.Шебанов

Институт теоретической и экспериментальной
физики, Москва, СССР

Изучалось рождение пар $K^0\bar{K}^0$ и K^0K^- π^--мезонами с импульсом 2,8 Бэв/с на ядрах H, C, Xe в пропан-ксеноновой пузырьковой камере. На распределении эффективных масс системы $K^0\bar{K}^0$ отчетливо выделяется пик при $M_{(K^0\bar{K}^0)}$ = I280 Мэв с шириной около I00 Мэв. Обсуждается возможность интерпретации этого пика на основе распада $f^0 \to K_1^0 + K_1^0$.

AN INVESTIGATION OF $K\tilde{K}$ PAIR-PRODUCTION REACTION BY π^--MESONS WITH MOMENTUM 2.8 BeV/c

V.V.Barmin, A.G.Dolgolenko, I.A.Erofeev, Yu.S.Krestnikov, A.G.Meshkovsky, G.D.Tikhomirov, Yu.V.Trebukhovsky, V.A.Shebanov

Institute of Theoretical and Experimental Physics, Moscow, USSR

The $K^0\tilde{K}^0$ and K^0K^- pair-production reaction at 2.8 BeV/c was studied on H.C.Xe nucleons with propan-xenon bubble chamber. The distribution of effective masses $K\tilde{K}$ has a noticeable bump at M ($K^0\tilde{K}^0$) = 1280 MeV and $\Gamma \cong 100$ MeV. A feasible interpretation of this bump as $f^0 \rightleftharpoons K^0_1 + K^0_1$ decay discussed.

УП-17

ПОИСКИ РАСПАДА $f^{\circ} \to \pi^{\circ} + \pi^{\circ}$

В.В.Бармин, А.Г.Долголенко, Ю.С.Крестников,
А.Г.Мешковский, В.А.Шебанов

Институт теоретической и экспериментальной
физики, Москва, СССР

С помощью пропан-ксеноновой пузырьковой камеры изучалась реакция $\pi^{-} + p \to n + 4\gamma$ при 2,8 Бэв/с. Сечение этой реакции равно 0,35 $\pm$ 0,08 мбн. Анализ углового распределения γ - квантов в реакции показывает, что около половины этого сечения можно объяснить за счет реакции $\pi^{-} + p \to n + f^{\circ}$ с распадом $f^{\circ} \to \pi^{\circ} + \pi^{\circ}$. Оценено отношение вероятностей распадов $\omega(f^{\circ} \to \pi^{+} + \pi^{-}) / \omega(f^{\circ} \to \pi^{\circ} + \pi^{\circ})$.

SEARCH FOR DECAY $f^0 \rightarrow \pi^0 + \pi^0$

V.V.Barmin, A.G.Dolgolenko, Yu.S.Krestnikov
A.G.Meshkovsky, V.A.Shebanov

Institute for Theoretical and Experimental Physics,
Moscow, USSR

The reaction $\pi^- + p \rightarrow n + 4\gamma$ at 2.8 BeV/c was investigated with a 17-liter propan-xenon bubble chamber. The cross section for the reaction is (0.35 ± 0.08) mb. About half of this cross section can be explained by the $\pi^- + p \rightarrow n + f^0$ reaction with the decay $f^0 \rightarrow \pi^0 + \pi^0$ as it follows from the angular distribution analysis of γ-quanta. The ratio of the probabilities $w(f^0 \rightarrow \pi^+ + \pi^-) / w(f^0 \rightarrow \pi^0 + \pi^0)$ was evaluated.

УП-19

ОЦЕНКА КОНСТАНТЫ ПРОЦЕССА $\gamma + \pi \to \pi + \pi$ ИЗ АНАЛИЗА РЕАКЦИИ $\pi^- + p \to \pi^- + \gamma + p$

Т.Д.Блохинцева, В.Г.Гребинник, В.А.Жуков,
А.В.Кравцов, Г.Либман, Л.Л.Неменов,
Г.И.Селиванов, Юань Жун-фан

Объединенный институт ядерных исследований
Лаборатория ядерных проблем

При анализе стереофотографий, полученных на жидководородной пузырьковой камере в пучке Π^- -мезонов с энергией 340 Мэв, идентифицировано несколько десятков случаев реакции $\pi^- + p \to \to \pi^- + \gamma + p$. На основании анализа полученного статистического материала делается вывод о вкладе полюсной диаграммы в сечение рассматриваемого процесса. Проведено сопоставление полученного результата с имеющимися теоретическими расчетами. Определена константа фоторождения П-мезона на П-мезоне.

ESTIMATION OF THE CONSTANT OF THE PROCESS $\gamma + \pi \to \pi + \pi$ FROM THE ANALYSIS OF THE REACTION $\pi^- + p \to \pi^- + \gamma + p$

T.D.Blokhintseva, V.G.Grebinnik, A.V.Kravtsov, G.Libman, L.L.Nemenov, G.I.Selivanov, V.A.Zhukov, Yang Run-fan

Joint Institute for Nuclear Research
Laboratory of Nuclear Problems

In analyzing stereopictures obtained with a liquid hydrogen bubble chamber in the negative pion beam some scores of events of the reactic $\pi^- + p \to \pi^- + \gamma + p$ have been identified. The analysis of the obtained statistical data allows to make a conclusion on the contribution of the polar diagram to the cross section of the process under consideration. The comparison of the obtained result with the available theoretical calculations has been made. The constant of pion-pion photoproduction has been determined.

VII-21

ADDITIONAL PROPERTIES OF THE 959-MeV MESON*

George R. Kalbfleisch, Orin I. Dahl, and Alan Rittenberg
(Presented by George R. Kalbfleisch)

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 12, 1964

ABSTRACT

Additional properties of the 959-MeV $\eta 2\pi$ meson are presented.[1,2] About 120 events will be available for the analysis of the J^P assignments from the Dalitz plots and decay angular correlations of the $\pi^+\pi^-\eta$ system. Results of a search for possible electromagnetic decay modes (2γ or $\pi^0\gamma$ and $\pi^+\pi^-\gamma$) will be presented, and branching ratios given.

PRODUCTION AND DECAY OF BOSON RESONANT STATES IN π^- + p INTERACTIONS AT 3.2 BeV/c*

Suh Urk Chung, Orin I. Dahl, Lyndon M. Hardy, Richard I. Hess, Janos Kirz, and Donald H. Miller

(Presented by D. H. Miller)

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 15, 1964

ABSTRACT

Production and decay correlations for the $\pi\omega$ resonance at 1220 MeV (B meson), the $\pi\rho$ state at 1090 MeV (A meson), and the $\pi\rho$ state at 1310 MeV (R meson) have been studied in detail. Interpretations will be presented in terms of possible quantum number assignments. In addition, evidence for the existence of other decay modes for the R-meson state, i.e., $R \rightarrow K\overline{K}$ and $R \rightarrow \pi\eta$, will be discussed.

Presented By
O. Piccioni at the 1964 DUBNA Conference

$\rho\,\pi$ Resonances

M. Abolins, D. D. Carmony, T. Hendricks,
Ng. h. Xuong and P. Yager

Physics Department
UNIVERSITY OF CALIFORNIA AT SAN DIEGO

In the reaction type $\pi^+ p \to \pi^- \pi^+ \pi^+$ at 3.54 GeV/c the $\rho\,\pi$ enhancement is observed as two peaks, one at $\backsim$1.1 GeV and another at $\backsim$1.3 GeV, in agreement with other observations.[1,2,3] The density distribution in the Dalitz plot for each peak is compared to that expected for each of the spin-parity assignment 0^-, 1^+, 1^-, 2^+, 2^-.

For the lower peak, the data do not fit very well the 1^-, 2^+, 0^- or 1^+ (ℓ=2) assignments, but are quite consistent with 2^- or 1^+ (ℓ=0). The existence of an $\eta\,\pi$ dacay mode, as suggested in reference 3, would require $J^P = 1^-, 2^+, 3^-, \ldots$

For the upper peak, the data fit rather poorly only the 0^-, 1^+ (ℓ=2) and 1^- assignment. The 2^+ assignment, suggested in reference 2, is consistent with the data as are 1^+ (ℓ=0) and 2^-.

[1] G. Goldhaber et al, Phys Rev. Letters 12, 336 (1964)
[2] S. U. Chung et al, to be published
[3] Aachen-Berlin-Birmingham-Bonn-Hamburg-London (I.C.)-Munchen Collaboration; to be published.

Multi-pion Annihilation of Antiprotons in Hydrogen at 7 Bev/c*

T. Ferbel, A. Firestone, H. Kraybill, J. Johnson, J. Sandweiss†, and H. Taft

Yale University

(to be presented by H. Taft)

In a continuation of our study of annihilation processes[1] approximately 1000 six-prong, 1000 four-prong, and 1000 two-prong events have been observed in the BNL 80 inch liquid hydrogen bubble chamber exposed to an electrostatically separated beam of 7 Bev/c antiprotons.[2] An excitation function for the production of ρ, ω, and f^0 mesons previously observed in lower energy annihilations is extended to this energy.

In addition, the results of a systematic search for resonances such as the A^+ and B mesons, recently observed in pion-nucleon collisions, as well as for new resonances, will be presented.

* Work performed under the auspices of the U. S. Atomic Energy Commission.

† Alfred P. Sloan Foundation Fellow

1. C. Baltay et. al., "Interactions of High Energy Antiprotons in Hydrogen", Stanford Nuclear Structure Meeting (1963).
2. I. Skillicorn and M. S. Webster; Status Report on High Energy Separated Beam for the 80 inch Chamber. BNL Internal Report H-10.

RESONANCE PRODUCTION IN 4 GeV/c π^+ PROTON INTERACTIONS WITH FOUR CHARGED SECONDARIES.

Aachen-Berlin-Birmingham-Bonn-Hamburg-London (IC)-München-Collaboration.

Results are presented on resonance production in 6000 π^+ proton interactions with four charged secondaries. Cross-sections for ρ, f^o, A and B meson production are presented together with results for pion-nucleon isobars in the $T = \frac{1}{2}$, $T = \frac{3}{2}$ and $T = \frac{5}{2}$ states. The decays of the meson resonances are discussed.

CHARGE EXCHANGE REACTION AND η PRODUCTION BETWEEN THE SECOND AND THIRD RESONANCE

A.Muller, E.Pauli, R.Barlautaud, J.Meyer
Laboratoire de Physique Corpusculaire a Haute Energie, CEN-Saclay
M.Beneventano, G.Gialanella, L.Paoluzi
Instituto di Fisica dell'Universita, Roma
Instituto Nazionale di Fisica Nucleare, Sezione di Roma

We present results on the reaction:

$$\pi^+ + n \rightarrow p + \quad (\text{neutrals})$$

A deuterium bubble chamber was exposed to a π^+ beam of 600, 650, 750, 800, 850 MeV kinetic energies.

Total and differential cross sections of the reactions:

$$\pi^+ + n \rightarrow p + \pi^0 \qquad (1)$$

$$\pi^+ + n \rightarrow p + \eta^0 \qquad (2)$$

are given.

The variation of the angular distribution coefficients of reaction (1) is presented and some conclusions are drawn concerning the interpretation of this variation.

A STUDY OF π^+p INTERACTIONS AT 4 GeV/c

Aachen-Berlin-Birmingham-Bonn-Hamburg-London (I.C.)
Munchen- Collaboration

Cross sections and branching ratios are presented for 15 000 π^+p interactions at 4 GeV/c .

Evidence for a backward peak in elastic scattering is presented. A study is made of the $\pi\pi$ cross section in the T=2 state from the reaction $\pi^+p \longrightarrow n\pi^+\pi^+$.

Eta Production by $\pi^- p \rightarrow \eta^\circ n$ and the total Neutral Cross Section of $\pi^- p$ for T_{π^-} from 500 to 1311 MeV. Vincent Z. Peterson, Robert J. Cence, and Victor J. Stenger, University of Hawaii, Honolulu, USA; Charles B. Chiu, Richard D. Eandi, Robert W. Kenney, Burton J. Moyer, John A. Poirier and W. Bruce Richards, Lawrence Radiation Laboratory, Berkeley, California, USA.-- The neutral modes of $\pi^- p$ interactions, including $\pi^\circ n$ and $\eta^\circ n$, have been observed at nine pion kinetic energies between 500 and 1311 MeV. A steel spark chamber complex 6 radiation units thick and covering 4π solid angle was used for a gamma-ray converter-detector. Two-gamma decays of π° are selected to study π° and η° cm angular distributions. A coincidence-anticoincidence counter array determines the total neutral cross-section; distinct peaks occur at 580 and 850 MeV in agreement with recent Saclay work.[1] The angular distributions for $\pi^- p \rightarrow \pi^\circ n$ are reported in a related abstract.[2] Eta production is also observed with a peak cross-section of 2.4±0.5 mb near 600 MeV; the cross-section rises abruptly above the 560 MeV threshold, and decreases rapidly above 600 MeV with no sign of peaking at 900 MeV. This behaviour leads naturally to speculation that the η° may be associated with only the 600 MeV resonance. The η° angular distributions appears nearly isotropic with slight forward peaking at all energies.

[1] Rene Turley, CEA 2136, p. 35 (1962).

[2] See abstract by B. J. Moyer, et al, this conference.

THE DUBNA INTERNATIONAL CONFERENCE

ON ELEMENTARY PARTICULES

Collaboration SACLAY ORSAY BARI BOLOGNE

-:-

ON THE ρ-MESON EXCHANGE MODEL FOR ISOBAR PRODUCTION .

-:-:-:-:-:-

3/2 3/2 isobar production by 2.75 GeV/c π^+ mesons in hydrogen bubble chamber have been studied. Results concerning the production cross section $\sigma_{\pi^+ p \to N^{*++} \pi^0}$ and the Stodolsky-Sakurai tests of the vector-meson exchange model for 3/2 3/2 isobar production will be presented.

-:-:-

List of authors :

- N. ARMENISE, B. GHIDINI, S. MONGELLI, V. PICCIARELLI, A. ROMANO and P. WALOSCHEK- Istituto di Fisica - BARI.
- J. LABERRIGUE-FROLOW, N'GUYEN HUU KHAN, M.SENE, C. OUANNES L. VIGNERON, - Laboratoire Joliot-Curie - Faculté des Sciences - ORSAY.

STUDY OF MULTIPARTICLE RESONANCES IN THE $\pi^+ p$ INTERACTION AT 3.65 BeV/c*

Gerson Goldhaber, Sulamith Goldhaber, and Benjamin Shen

(Presented by Sulamith Goldhaber)

Lawrence Radiation Laboratory
University of California
Berkeley, California

The resonance structures present in the four-particle final state of the π^+-p interaction, i.e.,

$$\pi^+ + p \rightarrow \pi^+ + \pi^- + \pi^+ + p, \qquad (1)$$

will be discussed. In addition to the dominant resonances in Eq. (1), i.e., ρ^0, $N^*_{3/2}(1238)$, and f^0, we find finer effects involving interactions between three particles. These are (a) the A^+ (A_1 and A_2) decaying into $\rho^0 + \pi^+$, (b) a $p\pi^+\pi^-$ mass enhancement at 1480 MeV which we associate with the $N^*_{1/2}(1510)$ isobar, and (c) a $p\pi^+\pi^+$ mass enhancement at 1580 MeV which if interpreted as a resonance would be an example of a $T = 5/2$ state, $N^*_{5/2}$. All above phenomena are associated with small momentum transfer to the multiparticle state.

We also find a marked enhancement in the $\pi^+\pi^-$ mass distribution at 390 MeV which is associated with the decay pions from the 1480-MeV $p\pi^+\pi^-$ peak. We thus interpret this enhancement to be most likely due to a kinematic constraint.

---

*Work sponsored by the U. S. Atomic Energy Commission.

Study of Di-Pion Resonances(*

J.H.Christenson, A.R. Clark,† J.W. Cronin,‡ R. Turlay‡‡

Princeton University, Princeton, New Jersey

We have employed two spark chamber spectrometers at the Brookhaven Cosmotron to study the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ at an incident pion momentum of 1.6 BeV/c. The equipment was designed to obtain a large sample of di-pions produced with very low momentum transfer to the recoil nucleon(Δ) with good mass resolution. The geometry of the apparatus allows us to see di-pions of mass m between 450 and 1000 MeV, with $\Delta_{min} < \Delta < \Delta_{min} + 2\mu$, where Δ_{min} is the lower kinematic limit on Δ, and μ is the pion mass, and with $-0.4 < \cos\theta_{\pi\pi} < 0.4$, where $\theta_{\pi\pi}$ is the angle between the incident and outgoing negative pion in the di-pion rest frame. Such an arrangement is particularly sensitive to $J = 0$ π-π resonances. We have analyzed 6300 events with a mass resolution of $\pm$ 4 MeV. About 4500 events are in the region of the ρ meson ($650 < m < 850$ MeV). We obtain a mass for the ρ meson of 730 MeV, with a full width at half maximum of 120 MeV. We find no evidence of any other resonances. Our data is consistent with the value zero for the branching ratio $R = \frac{\omega \rightarrow \pi^+ + \pi^-}{\omega \rightarrow \text{all decays}}$.

*) Work supported by U. S. Office of Naval Research.

† National Science Foundation Predoctoral Fellow.

‡ A. P. Sloan Foundation Fellow.

‡‡ On leave from L.P.C.H.E., CEN, Saclay, France.

DI-PION MASS SPECTRUM FROM π^- p COLLISIONS AT 4 BEV/C*

D. Keefe, L. T. Kerth, C. M. Noble, J. J. Thresher,†
W. A. Wenzel, and T. F. Zipf‡

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 20, 1964

ABSTRACT

The final-state π-π interaction in the process $\pi^- + p \rightarrow \pi^+ + \pi^- +$ (missing mass) has been studied at an incident momentum of 4 Bev/c by means of a magnetic spectrometer using spark chambers.(1) A lead and scintillator "sandwich" counter system surrounding part of the hydrogen target rejected highly inelastic events to enhance detection of the $\pi^+\pi^-n$ final state. About 2000 out of the 6000 measured two-prong events were identified as $\pi^+\pi^-n$. With a resolution in missing mass of ± 90 Mev, the $\pi^+\pi^-n+(n\pi^o)$ background in the $\pi^+\pi^-n$ sample is reduced to a few percent. The resolution in the di-pion mass is less than ± 20 Mev.

---

*Work done under the auspices of the U. S. Atomic Energy Commission.

†Present Address: National Institute for Research in Nuclear Science
Rutherford High Energy Laboratory
Didcot, Berkshire, England

‡Present Address: Brookhaven National Laboratory
Upton, Long Island, New York

(1) A Magnetic Spectrometer Using Spark Chambers to Obtain Large Solid Angle and High Resolution in π-π Interaction Studies, Nuc. Instr. Meth. 20, 171-172 (1963).

π^-p INTERACTION AT 3.7 BeV*

Gerson Goldhaber, Sulamith Goldhaber, John A. Kadyk,
Benjamin C. Shen, and George H. Trilling

(Presented by Sulamith Goldhaber)

Lawrence Radiation Laboratory
University of California
Berkeley, California

Interactions of π^- mesons in the Berkeley 72-in. hydrogen bubble chamber have been studied at 3.7 BeV/c. These data were analyzed with the Berkeley "flying spot digitizer" (FSD). The four-charged-particle final state ($\pi^-\pi^+\pi^-$p) has been compared with that produced by interactions of π^+ mesons with hydrogen ($\pi^+\pi^-\pi^+$p). The following phenomena observed in the four-particle final state will be discussed:

(a) the $\pi^-\rho^0$ states, A_1^- and A_2^-

(b) the three-particle interaction p$\pi^-\pi^+$

(c) the decay asymmetry of the ρ^0 and its interpretation.

---

*Work sponsored by the U. S. Atomic Energy Commission.

COHERENT PHOTOPRODUCTION OF π^o ON He^4.

J. Lefrançois, P. Lehmann
J.P. Repellin

The aim of this experiment is to study the reaction

$$\gamma + He^4 \rightarrow \pi^o + He^4$$

for photon energies between 250 MeV and 650 MeV, which corresponds to the region between the P_{33} and D_{13} resonance on free nucleon photoproduction.

The detection of recoil He^4 allows only magnetic transitions and forbids electric transitions.

A triple focussing spectrometer is used. The angle and momentum of He^4 are determined by the 2 first magnets of the spectrometer and an absorber between the second and the third magnet allows a mass separation to be done.

The aim of this experiment is twofold :

1) To check the presence or the absence of P_{11} resonance at 510 MeV (in the π.N. system). This resonance can be excited by magnetic transition, the D_{13} resonance being on the contrary mainly electric.

2) Detecting recoil He^4 at 0°, the reaction $\gamma + He \rightarrow \pi^o + He^4$ is strictly forbidden, but $\gamma + He^4 \rightarrow \rho^o(\omega^o) + He^4$ is allowed. It is thus possible to measure this last reaction with a very small background .

We think to have complete results on the first part of this experiment in time for the Dubna conference.

BOSON RESONANCES IN 3.5 GeV/c K^- - PROTON INTERACTIONS

Bubble Chamber film analysis groups of Birmingham and Glasgow Universities
Imperial College London , Oxford University and Rutherford Laboratory.

Properties of the f^o *

N. GELFAND, G. LÜTJENS and J. STEINBERGER

Columbia University, New York, New York

Results on the spin and isospin of the f^o will be presented on the basis of the reactions

$$\pi^+ + d \rightarrow p + p + \pi^+ + \pi^-$$

and

$$\pi^+ + d \rightarrow p + p + \text{neutrals}$$

---

* Work supported in part by the U. S. Atomic Energy Commission.

Multipion Final State for Interactions of Positive Pions in Deuterium at 2.5 BeV/C*

U. E. Kruse, G. Ascoli, E. L. Goldwasser, D. Richardson, R. D. Sard, G. Thiel

Participant who will present paper - E.L. Goldwasser
Physics Department, University of Illinois, Urbana, Illinois

We have studied the multipion final states formed by 2.5 BeV/C positive pions in the BNL 20" Bubble Chamber filled with deuterium. We have obtained a branching ratio for the decay of the f°. For approximately one-half the data we find the ratio

$$\frac{f_o \rightarrow \text{neutrals}}{f_o \rightarrow \pi^+ \pi^-} = .96 \pm .3$$

With the neutral decays we have found pairs from γ-ray conversions in deuterium and a Dalitz pair. These are consistent with the mode $f_o \rightarrow 2\pi^\circ$.

The mass spectra and angular distributions for the reactions

$$\begin{aligned} \pi^+ d &\rightarrow pp + \text{neutrals} \\ &\rightarrow pp\ \pi^+\pi^- \\ &\rightarrow pp\ \pi^+\pi^- + \text{neutrals} \\ &\rightarrow pp\ \pi^+\pi^-\pi^+\pi^- \\ &\rightarrow pp\ \pi^+\pi^-\pi^+\pi^- + \text{neutrals} \end{aligned}$$

will be presented.

One Pion Production by π^+ in Hydrogen at 3.5 BeV/c*

D. Duane Carmony, Duong N. Hoa, Richard L. Lander,
Nguyen-huu Xuong, and Philip Yager

Physics Department
UNIVERSITY OF CALIFORNIA, SAN DIEGO

Approximately 7000 two prong events in the Brookhaven 20 inch hydrogen bubble chamber have been analyzed. We have obtained 732 $n\pi^+ \pi^+$ events (1.48 ± .05 mb) and 1061 $p\pi^+ \pi^o$ events (2.15 ± .07 mb). In the former we see no indication of any resonances or enhancements in the $\pi^+\pi^+$ mass spectrum in the range 2 to $12m_\pi$. In the latter 204 events are ρ^+ (0.41 ± .03 mb) and 118 events (0.24 ± .02 mb) are in the f region ($M_{\pi^+\pi^o}$ = 1240 ± 80 MeV). No significant peak above background is observed in the f region. We establish an upper limit above background of 0.06 mb for f^+ production. Utilizing published cross section data for f^- (<.06 mb) and f^o (.3 ± .05 mb) production we will discuss the triangular inequality which would be satisfied if the f meson were an isotriplet. The pion-pion angular distributions show the presence of T = 2 d-wave for dipion masses greater than 1 BeV.

Research supported by the U. S. Atomic Energy Commission (Contract No. AT(11-1) GEN 10, PROJECT 10 MOD 3).

A SEARCH FOR THE DECAY OF f^0 IN TWO

Ecole Polytechnique - Paris
Istituto di Fisica dell'Università and INFN - Milano
C.E.R.N. - Genève
C.E.A. - Paris

In the heavy liquid bubble chamber of the Ecole Polytechnique BP_3, exposed at CERN PS, a search was made for neutral f^0 decay, $f^0 \longrightarrow 2\pi^0$, to reject odd spin for that particle. 8 gev/c π^- hitted protons of a hydrogen target inside the chamber and π^0 were reconstructed from the measurement of γ quantum through their materialisation in the heavy liquid in $e^+ e^-$ pairs. Results will be presented for production cross-section and angular distributions.

MESON PRODUCTION IN π^+-d INTERACTIONS AT 6 GEV/C

F. Bruyant, M. Goldberg[i], G. Vegni[ii], and H. Winzeler
CERN, Geneva

P. Fleury, J. Huc, R. Lestienne, G. de Rosny and R. Vanderhaghen
Ecole Polytechnique, Paris

70,000 pictures of the 81cm Saclay bubble chamber filled with deuterium and exposed with 6.07 GeV/c π^+-mesons, have been scanned.

Reactions of the following types were analyzed :

$$\pi^+ + d \longrightarrow p + p + \text{neutrals}$$
$$\pi^+ + d \longrightarrow p + p + \pi^+ + \pi^-$$
$$\pi^+ + d \longrightarrow p + p + \pi^+ + \pi^- + \pi^0$$
$$\pi^+ + d \longrightarrow p + p + \pi^+ + \pi^- + n\pi^0 \quad (n > 1).$$

Results will be given, especially about the production of heavy mesonic resonances.

---

i) On leave of absence from Institut de Radium, Laboratoire Curie, Paris

ii) On leave of absence from the University and Section of I.N.F.N. of Milan

AN EXPERIMENTAL STUDY OF THE - MESON AS A SCATTERING RESONANCE

Y. Y. Lee, B. P. Roe, Daniel Sinclair, and J. C. Vander Velde
University of Michigan
Ann Arbor, Michigan

An experimental study has been made of the reactions $\pi^- + p \rightarrow \rho^0 + n$, $\rho^0 \rightarrow \pi^+ + \pi^-$. Under the assumption of one pion exchange (OPE) the ρ resonance is produced by the interaction of the primary pion with a single pion of the nuclean cloud. By assuming such a model for ρ production and by doing a partial wave analysis of the π-π scattering distributions for different regions of the ρ mass and for different regions of momentum transfer, the following conclusions are reached:

1) The S-wave phase shift is large ($75^\circ \pm 35^\circ$) throughout the ρ region

2) By extrapolating the P - wave term to the real pion pole (i.e. $\Delta^2/\mu^2 = -1$), the cross section for pure ρ^0 production is used to provide an estimate of the pion-nuclean coupling constant which is in good agreement with other determinations.

3) The overall consistency of this approach corroborates the assumption of OPE as the dominant diagram for ρ production.

MULTIPION PRODUCTION IN π^++p COLLISIONS AT 2.75 GeV/c

Saclay-Orsay-Bari-Bologna Collaboration

J. Laberrigue-Frolow, N'Guyen Huu Khan, M. Sené, G. Tridon, L. Vigneron, Yiou-Tchiu-Pung:
Laboratoire Joliot-Curie, Faculté des Sciences, Orsay.

N. Armenise, B. Ghidini, S. Mongelli, V. Picciarelli, A. Romano, P. Waloschek:
Istituto di Fisica dell'Università, Bari.

Several results obtained from the analisis of the following reactions

$$\pi^+ + p \longrightarrow \begin{cases} p + \pi^+ + \pi^+ + \pi^- \\ p + \pi^+ + \pi^+ + \pi^- + \pi^0 \\ p + \pi^+ + \pi^+ + \pi^- + n\,\pi^0 \quad (n > 1) \\ p + \pi^+ + n\,\pi^0 \quad (n > 1) \end{cases}$$

observed in a H_2- bubble chamber are presented. The well known ω^0 and η^0 resonances are clearly observed. Possible other resonances are particularly investigated in the presented report.

MESON PHOTOPRODUCTION

A.Silverman, A.D.Franklin, D.R.Rust, C.K.Sinclair, R.Talman,

Cornell University, Ithaca, New York

We are measuring the cross-section for the reaction $\gamma + p \longrightarrow \pi^+ + \pi^- + p$ with particular attention to the photoproduction of the ρ-meson. Two of the three final state particles are detected and their kinematics determined in two magnetic spectrometers in which the trajectories are determined by spark chambers. Measurements have been carried out for ρ-meson center of mass angles between 0° and 120° and the γ-ray laboratory energies between 1100 Mev and 1250 Mev. The wide angle data agrees qualitatively with previous measurements[1]. The most conspicuous feature of the results is that the ρ-meson is not produced preferentially in the forward direction where the four momentum transfer to the nucleon is smallest. This result implies that the ρ photoproduction is not dominated by the exchange of a π^o. The $\Gamma_{\rho \to \pi\gamma}$ deduced from this assumption and the previous wide angle data is, therefore, probably incorrect[2].

[1] D. McLeod, S. Richert, A. Silverman, P.R.L. 7, 383 (1961).

[2] S. M. Berman and S. D. Drell, Phys. Rev. 133, 794 (1964).

PRODUCTION OF φ AND ω PARTICLES IN ANTI-PROTON-NEUTRON ANNIHILATIONS AT REST

V.Barnes and K.Lai (B.N.L.)
P.Anninos, L.Gray, P.Hagerty, E.Harth, T.Kalogeropoulos, S.Zenone (Syracuse University)
R Bizzarri, U.Dore, G.Gialanella, P.Guidoni, G.C.Moneti (Roma University)

Brookhaven National Laboratory Siracuse University
Istituto di Fisica Universita di Roma e Sezione di Roma dell'I.N.F.N.

In 30 000 Antiproton neutron annihilations at rest observed in the BNL 32" deuterium Bubble Chamber. The rates for reaction

$$\bar{p} + n \rightarrow \varphi + \pi^-$$
$$\bar{p} + n \rightarrow \omega + \pi^-$$

were determined. These rates are compared with those of φ and ω production in π^-p and K^-p reactions.

π^+ P Cross Sections Below 4 BeV*

F. E. James, H. L. Kraybill, J. A. Johnson

Yale University
(to be presented by H. D. Taft)

We have completed a compilation of results from π^+P experiments between 1 and 4 BeV, showing the energy dependence of the following cross sections:

$$\pi^+ p \rightarrow \pi^+ p$$
$$\rightarrow \pi^+ p \pi^o$$
$$\rightarrow \pi^+ \pi^+ n$$
$$\rightarrow \pi^+ p \pi^+ \pi^-$$
$$\rightarrow \pi^+ p \pi^+ \pi^- \pi^o$$
$$\rightarrow \pi^+ \pi^+ \pi^+ \pi^- n$$
$$\rightarrow \rho^+ p$$
$$\rightarrow \pi^+ p \rho^o$$
$$\rightarrow \pi^+ p \omega^o$$
$$\rightarrow \pi^+ p \eta^o$$

We also present elastic differential cross sections based on 3000 events at 1.76 BeV/c and 3000 events at 2.08 BeV/c, with no significant biases down to $\cos \theta$ (c. m.) = 0.98.

Multi-pion Production by Negative Pions in Hydrogen at 6 Bev/c*

V.E. Barnes, W.B. Fowler, K.W. Lai,
D. Radojicic, D.C. Rahm
M.S. Webster
Brookhaven National Laboratory
Upton, L.I., N.Y.
and
A.H. Bachman, P. Baumel, R.M. Lea
College of the City of New York
New York, N.Y.

The Brookhaven 80-inch liquid hydrogen bubble chamber has been exposed to a 6 Bev/c negative pion beam from the AGS. Approximately 1,500 four-prong events have been measured The results of a systematic search for resonances will be presented.

Final State Interactions in $\pi^+ + p$ Collisions at 2.77 Bev/c*

J.L. Lloyd, D.C. Rahm, J.R. Smith, S.S. Yamamoto
Brookhaven National Laboratory, Upton, L.I., New York

Approximately 5000 four-prong events from 2.77 Bev/c π^+ - p collisions have been analyzed. They are of the type: a) $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^- + p$, b) $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^- + \pi^o + p$, and c) $\pi^+ + p \rightarrow \pi^+ + \pi^+ + \pi^+ + \pi^- + n$. Reaction a) goes strongly via $\rho + N^*$ or $N^* + \pi^+ \pi^-$, and reaction b) via $N^* + \omega$. An interpretation of these reactions in terms of a single particle exchange model will be presented.

Production of $\rho\pi$ resonances from antiproton annihilation at rest with protons

by

A.BETTINI, M.CRESTI, A.GRIGOLETTO, S.LIMENTANI, A.LORIA, L.PERUZZO, R.SANTANGELO.

Istituto di Fisica dell'Università - Padova
Istituto Nazionale di Fisica Nucleare - Sezione di Padova.

G.B.CHADWICK, W.T.DAVIES, M.DERRICK, C.J.B.HAWKINS, P.M.D.GRAY, J.H.MULVEY, P.B.JONES, D.RADOJICIC, C.A.WILKINSON.

Nuclear Physics Laboratory - Oxford University.

- ^ - ^ -

We have looked in the reactions:

(1) $\bar{p} + p \rightarrow \pi^+ + \pi^- + \pi^+ + \pi^-$

(2) $\bar{p} + p \rightarrow \pi^+ + \pi^- + \pi^+ + \pi^- + \pi^0$

coming from antiprotons stopping at rest in the Saclay 80 cm. hydrogen bubble chamber, for the production of resonances in the $\rho\pi$ system, that have been observed by Goldhaber at al.[1] and by the Aachen - Berlin - Birmingham - Bonn - Hamburg - London - Muenchen collaboration[2]. Reaction (1) is particularly suitable for this purpose since it has been shown to go mainly through the channel $\bar{p} + p \rightarrow \rho^0 + \pi^+ + \pi^-$. The ρ is produced abundantly also in the second reaction, but the copious production of the ω and the large number of two and three-pion masses that can be made with five pions make the analysis more difficult.

We have indications of the production of the two resonant states reported in reference 2.

Work is still in progress, to increase the statistical significance of the data, and to attempt to restrict the choice of possible assignements for the quantum numbers of the resonances.

References

1) G.Goldhaber, L.J.Brown, S. Goldhaber, J.A.Kadyk, B.C.Shen, G.H.Trilling: Phys. Rev. Lett. 12, 336 (1964).

2) The observation of two $\rho\pi$ resonances: Aachen - Berlin - Birmingham - Bonn - Hamburg - London (I.C.) - Muenchen: Collaboration. Submitted to Phys. Lett.

D + W Production

R. Good, W. Mehlhop, O. Piccioni, R. Swanson
University of California, San Diego

The production of W bosons in the reaction P + P → D + W is computed by comparison with the multiple meson production reaction P + P D + π's. Arguments are given why the comparison should not be made in respect to any one particular channel of pion production, but rather to all possible channels.

An experiment in preparation to detect D + W production is described briefly.

Coherent production of three-Pion Final States by 16 gev Negative Pions on Nuclei

Ecole Polytechnique - Paris
University of California - Berkeley
Istituto di Fisica dell'Università and INFN - Milano
C.E.R.N. - Genève
C.E.A. - Paris

Following previous results about nuclear coherent diffraction of high energy π^- we studied, in the heavy liquid bubble chamber of the Ecole Polytechnique BP_3 exposed at CERN PS, 3π production by 16 Gev/c π^- according to $\pi^- + N \rightarrow \pi^- + \pi^- + \pi^+ + N$. High γ ray materialisation power of the liquid prevent our sample to be contaminated by interactions where extra π^0 are produced. At the same time all interactions showing evaporation prongs were rejected. We present histograms of 2π and 3π masses, along with Δ^2 and angular distributions. Existence of a new resonance and possible assignments for its quantum numbers will be discussed.

Studies of 2π and 3π Resonant States*

T. C. Bacon, D. G. Hill, H. W. K. Hopkins, D. K. Robinson and E. O. Salant
Brookhaven National Laboratory, Upton, Long Island, New York

With 1.7 BeV/c pions incident on the 20-inch Brookhaven National Laboratory bubble chamber filled with deuterium, the reactions

$$\pi^+ + n \rightarrow p + \pi^+ + \pi^-$$
$$\rightarrow p + \pi^+ + \pi^- + \pi^o$$

were studied as a function of four momentum transfer to the target nucleon. The analyses seek to establish the extent to which ρ production proceeds by one-pion exchange and ω production proceeds by ρ exchange, and to establish the branching ratio $\frac{\omega \rightarrow 2\pi}{\omega \rightarrow 3\pi}$ (the 2π decay for the charge-symmetric $\pi^- p$ reaction at the same incident pion energy has been reported previously[1]).

π-π Interactions

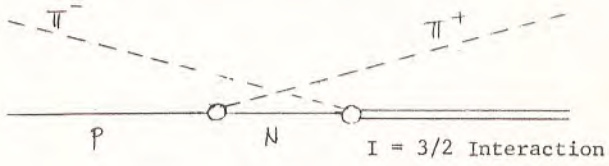
W. D. Walker, E. West, J. Boyd, A. R. Erwin, M. A. Thompson
University of Wisconsin, Madison, Wisconsin, U.S.A.

We have completed our work on the interaction of 2 BeV π^- with protons. In the course of this work approximately 28,000 2 prong events were measured.

The pion production events for low momentum transfers are quite consistent with one pion exchange. We have extrapolated to find π-π cross sections in the region of the ρ. We find no evidence for a sharp s-wave resonance in the I = 0 state of the π-π system in the 400-600 MeV region. Our results still seem to indicate some evidence of an interference between $\omega \rightarrow 2\pi$ and the ρ meson.

There is evidence for the importance of other diagrams in the pion production process which have characteristically low momentum transfers. This evidence comes not only from pion production but also from the production of strange particles.

The simplest diagram which could give rise to this phenomenon is the crossed diagram as shown below.



I = 3/2 Interaction

STUDY OF THE REACTION $\pi^- p \rightarrow N^{*++}_{33} \pi^- \pi^-$ AND $\pi\pi$ ELASTIC SCATTERING

J.Alltti, J.P.Baton, A.Berthelot, B.Deler, W.J.Fickinger, M.Neveurene

Laboratoire de Physique Corpusculaire à Haute Energie, CEN-Saclay;

A.Alles-Borelli, R.Gessaroli, A.Romano

P.Waloschek

Istituto di Fisica dell'Universita di Bologna

SACLAY-ORSAY-BARI-BOLOGNA - Collaboration

The four body reaction $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$ has been studied with incident π^- of 2.75 GeV/c in the 81 cm D Saclay LHBC at the CERN PS.

One important channel is

$$\pi^- p \rightarrow N^{*++}_{33} \pi^- \pi^-$$

where the isobar is produced according to the O.P.E. mechanism giving the possibility of studying the $\pi\pi$ elastic scattering in the pure T = 2 state.

The elastic cross section and angular distributions as a function of the dipion energy are investigated; resylts are compared with the $\pi\pi$ scattering in other charge states.

The four momentum transfer distribution to the N^{*++}_{33} isobar is discussed.

The Reaction $\pi^+ + p \rightarrow N_{33}^{*++} + \pi^o$ at 3.5 BeV/c

M. Abolins, D. D. Carmony, D. N. Hoa, R. L. Lander
C. Rindfleisch and Ng. H. Xuong
University of California , San Diego

After analyzing 7000 two prong events from a π^+ exposure at 3.54 BeV/c in the Brookhaven 20" hydrogen bubble chamber, we identified about 100 events of the type

$$\pi^+ + p \rightarrow N_{33}^{*++} + \pi^o \quad (1) \text{ with } N_{33}^{*++} \rightarrow p + \pi^+$$

which gives a cross section of .20 ± .04.mb

We find a very good agreement between the angular correlations observed in the decay of the N_{33}^{*} and the predictions by Stodolsky and Sakurai using a single ρ exchange model.

The reaction $K^+ + p \rightarrow N_{33}^{*++} + K^o$ (2) has also been found to display similar angular correlations in agreement with the single ρ exchange mechanism. But we want to point out that the cross sections of both reactions (1) and (2) decrease with energy in strong contradiction with the results derived from a single ρ exchange model as used by Jackson and Pilkuln or Stodolsky and Sakurai.

FOUR-PRONG INTERACTIONS OF 8 GeV/c π^+ IN HYDROGEN

Aachen - Berlin - CERN Collaboration

Results will be presented on the analysis of about 3,000 four-prong interactions of 8 GeV/c π^+ in the Saclay 81cm hydrogen bubble chamber. Production of resonances and isobars will be discussed, in particular in terms of the "principal axis" of the collision.

Investigation of Exchange Mechanisms in π^+p Interactions at 4 GeV/c

Aachen-Berlin-Birmingham-Bonn-Hamburg-London (I.C.)-München
Collaboration.

From a study of 15 000 π^+p interactions at 4 GeV/c a detailed investigation is made of the exchange mechanisms involved in the production of resonant states. Specifically the interactions $\pi^+p \to N^{*++}\pi^o$, $\pi^+p \to p\rho^+$, $\pi^+p \to N^{*++}\omega^o$ are considered.

DIBOSON PRODUCTION BY PIONS OF 12 AND 18 GEV/C

L. W. Jones* - University of Michigan
D. Harting, W. Middelkoop, and B. Zacharov - CERN, Geneva
D. O. Caldwell** - Princeton University
E. Bleuler*** - Purdue University
B. Elsner - Desy, Hamburg

Analysis of a spark chamber experiment performed at CERN on production by 12 and 18 Gev/c pions of dipions, dikaons, and kaon-pion states confirms the well-established diboson resonances. Over 10,000 events are being analyzed for the mass spectra, recoil nucleon system mass, momentum transfer, and other kinematic variables. Computation of the solid angle bias corrections has delayed interpretation of the results; however, resolution of this problem is now permitting quantitative comparison of differential cross sections with theory.

Among early results of note is the dominance of heavy recoiling nucleon systems in preference to single nucleon and 3/2 isobar production. The good mass resolution at this energy permits a fine-grained search for new states, particularly at low dipion masses where excellent statistics are available. The results of this experiment, which is still being analyzed, will be presented and discussed.

Non-Strange Resonances in 1.76 Bev/c π^+-p Collisions*

J. A. Johnson and H. L. Kraybill

Yale University

(to be presented by H. D. Taft)

9000 π^+-p collisions arising from an exposure of the 20 inch BNL hydrogen bubble chamber to a beam of 1.76 Bev/c π^+ mesons are being analyzed. A discussion of the cross sections and production mechanisms of the following interactions will be presented.

$$\pi^+ + p \rightarrow \omega^o + N_{3/2}^*$$
$$\rightarrow \eta^o + N_{3/2}^*$$
$$\rightarrow \rho^+ + p$$
$$\rightarrow \rho^o + N_{3/2}^*$$
$$\rightarrow N^* + \pi$$

Branching ratios for the neutral decays of the ω^o and the η^o will be reported. Studies of the $\pi^+ n$ isobar decays, and possible resonances in the T = 2 dipion final state will be presented.

Production of Pions in $\pi^+ p$ Collisions at 2.08 Bev/c*

F. E. James and H. L. Kraybill

Yale University
(to be presented by H. D. Taft)

We report the results of a study of 9000 2-pronged and 3000 4-pronged interactions of π^+ mesons at 2.08 BeV/c in the B. N. L. 20" hydrogen bubble chamber. As is the case at nearby energies, strong production of resonances is observed in this experiment, and we have fitted our data to production of resonances through the following channels:

$\pi^+ p \rightarrow \rho^+ p$	2.19 ± 0.20 mb.
$\rightarrow \pi^+ p\rho^o$	0.91 ± 0.10 mb.
$\rightarrow \pi^+ p\omega^o$	1.47 ± 0.21 mb.
$\rightarrow \pi^+ p\eta^o$	0.74 ± 0.14 mb.
$\rightarrow N_{33}^* \omega^o$	1.22 ± 0.21 mb.
$\rightarrow N_{33}^* \pi^+ \pi^-$	2.06 ± 0.20 mb.
$\rightarrow N_{33}^* \pi^o$	0.60 ± 0.09 mb.
$\rightarrow N_{15}^* \pi^+$	0.37 ± 0.07 mb.

Angular distributions of production and decay of the resonances have been measured, in order to study possible production mechanisms involved. These data are presented, as well as data on the branching ratios for the decays of η^o and ω^o.

The production of N_{33}^{*++} in $\pi^+ p$ interactions at 1.6 GeV/c

A.DAUDIN, M.A.JABIOL, C.KOCHOWSKI, C.LEWIN,
Laboratoire de Physique Corpusculaire à Haute Energie, CEN-Saclay

S.MONGELLI, A.ROMANO, P.WALOSCHEK,
Istituto di Fisica dell'Universita, Bari.

ABSTRACT

Improved statistics on the results obtained in investigations of $\pi^+ p$ interactions at 1.6 GeV/c yields for the reaction

$$\pi^+ \, p \longrightarrow N_{33}^{*++} \, \pi^0$$

a cross section of 1 mb.

The c.m. angular distribution of the isobar indicates a predominant peripheral interaction.

The distribution of the Treiman-Yang angle is in good agreement with the distribution in $1 + 2\sin^2\varphi$ given by STODOLSKY and SAKURAI, assuming the exchange of a ρ meson in the interaction. The angular distribution of the π^+ arising from the decay of N_{33}^{*++}, relative to the normal to the production plane in the isobar rest system, is also consistent with their predictions. Results are compared with those obtained at different π^+ energies.

The associated production of N_{33}^{*++} and η in

$$\pi^+ \, p \longrightarrow N_{33}^{*++} \, \eta$$

interactions has been observed, the η decaying in the neutral mode. The corresponding cross section is 0.3 mb.

Pion resonances in π^+ d interactions at 4.5 GeV/c

SACLAY-ORSAY-BARI-BOLOGNA Collaboration(*)

The experiment was carried out at the CERN PS by means of the 81 cm Saclay L.D.B.C.

The interactions investigated are :

$\pi^+ d \longrightarrow p_s\ p$ + neutrals (1)

$p_s\ p\ \pi^+\ \pi^-$ (2)

$p_s\ p\ \pi^+\ \pi^-\ \pi^o$ (3)

$p_s\ p\ \pi^+\ \pi^-\ (k>1)\pi^o$ (4)

where p_s represents the spectator proton.

Invariant mass spectra associated to the two protons in the various channels were investigated.

The $\pi^+\pi^-$ mass spectrum in (2) exhibits strong ρ^o and f^o peaks over a relatively low background. The neutral mass spectrum in (1) shows a complicated behaviour, which is currently being analysed, especially in the 1.250 GeV region.

The tripion mass spectrum in (3) shows, in addition to ω^o, a peak at 1320 MeV and at 1650 MeV. The latter possibly is a kinematical reflexion of the N^*_{33} isobar. It is not yet clear whether the 1320 peak is the neutral partner of the positive and negative peaks observed at the same mass by different groups in $\pi^{\pm}$ p interactions. Results will also be given on the shape and on the interpretation of the multipion mass spectra in channel (4).

VII-62

PRODUCTION OF NUCLEON ISOBARS BY 7 BEV/C PROTONS*

C. M. Ankenbrandt, A. R. Clyde, Bruce Cork, D. Keefe,
L. T. Kerth, W. M. Layson, and W. A. Wenzel

Lawrence Radiation Laboratory
University of California
Berkeley, California

We have measured the missing mass spectrum of nucleon isobars produced in the reaction $p + p \rightarrow N^* + p$ by 7 Bev/c protons incident on a liquid-hydrogen target. Scintillation counters detected the scattered protons after momentum analysis. Cross sections were obtained for production of isobars of mass 1238, 1512, and 1688 Mev at momentum transfers of 0.09, 0.15, 0.24, 0.33, and 5 $(\text{Bev/c})^2$. For low momentum transfer, the spectrum has additional structure at a mass of about 1430 Mev. The $T = \frac{1}{2}$ isobar production cross sections at $-t = 5$ $(\text{Bev/c})^2$ are comparable with the elastic-scattering cross section.

OBSERVATION OF $N^{*} + \pi$ DECAY MODES OF THE HIGHER PION-NUCLEON RESONANCES

W.D.C.Moebs, B.P.Roe, D.Sinclair, and J.C.VanderVelde

The University of Michigan
Ann Arbor, Michigan

In analyzing a 3.7 GeV/c π^- experiment in a hydrogen bubble chamber we have singled out the reactions (1) $\pi^- p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ and (2) $\pi^- p \rightarrow n\pi^+\pi^+\pi^-\pi^-$. In selecting a subsample of reaction (1) which goes via $\rho^- + N^*(1238) + \pi$ we find that the $N^{*-}\pi$ mass spectrum shows the three prominent peaks at 1520, 1700, and 1900 MeV. We interpret these as $N^* + \pi$ decay modes of the established pion nucleon resonances at 1515, 1685, and 1920 MeV. The data are consistent with the entire subsample going through these two-body channels.

Production processes, branching ratios into other modes, and possible similar effects in reaction (2) are also discussed.

EXCITED STATES OF BARYONS

P. Carruthers, Laboratory of Nuclear Studies, Cornell University, Ithaca, New York, U.S.A.

The resonance spectrum in the scattering of baryons from pseudoscalar mesons, with especial attention to the pion-nucleon problem, has been investigated theoretically. In the πN problem the elastic forces due to the exchange of particles on the nucleon trajectory are shown to induce strong attractive forces in the proper states on the 3-3 resonance (N*) trajectory. The exchange of the particles on the N* trajectory give strong attractive forces in the states comprising the nucleon trajectory. ρ meson exchange also gives rise to significant attractive forces in the states of the nucleon and N* trajectories. The principal inelastic mechanisms enhance the effect of the aforementioned elastic forces and are essential for the generation of the 600 Mev $\pi^- p$ resonance and the 850 Mev $\pi^+ p$ shoulder. The above mechanism has been generalized to the case of octets of mesons and baryons interacting through forces invariant under transformations of the group SU(3), with similar results.

ABSTRACT FOR DUBNA CONFERENCE

SINGLE PION PRODUCTION IN $p-\bar{p}$ INTERACTIONS AT 4.0 GEV/c

O. Czyzewski*, B. Escoubes**, Y. Goldschmidt-Clermont, M. Guinea-Moorhead, T. Hofmokl***, D.R.O. Morrison, and S. de Unamuno-Escoubes+,

CERN, Geneva

Photographs from the 81cm Saclay H.B.C. operating in a 4.0 GeV/c separated antiproton beam were used to study two-prong $p-\bar{p}$ interactions, yielding 676 interactions of the type $p\bar{p} \rightarrow N\bar{N}\pi$. The values of the cross-sections for the different channels are as follows :

$$\sigma(p\bar{p}\pi^0) = (2.01 \pm 0.23)\text{mb}$$
$$\sigma(p\bar{n}\pi^-) = (2.61 \pm 0.27)\text{mb}$$
$$\sigma(n\bar{p}\pi^+) = (2.65 \pm 0.27)\text{mb}.$$

The mechanism of the interaction, especially the 3/2, 3/2 isobar and anti-isobar formation is discussed in terms of the Ferrari-Selleri One-Pion-Exchange model. It is found that the form factors used by Ferrari and Selleri to calculate the pion production in proton-proton collisions in the T=3/2 region give a reasonable fit to our experimental data, whereas those used in the T-1/2 region are in disagreement with the experiment. A possible explanation will be discussed, as well as the role of the final state $N-\bar{N}$ interaction.

Anti-Isobar Production in $\bar{p}n$ Interactions*

T. C. Bacon, H. W. K. Hopkins, D. K. Robinson, E. O. Salant
Brookhaven National Laboratory, Upton, Long Island, New York

and

A. Engler, H. E. Fisk, C. M. Meltzer and J. B. Westgard
Carnegie Institute of Technology, Pittsburgh, Pennsylvania

Study of events in the Brookhaven National Laboratory 20-inch deuterium-filled bubble chamber, exposed to 2.0 BeV/c anti-protons from the AGS, has revealed 850 examples of the reaction $\bar{p} + n \rightarrow p + \bar{p} + \pi^-$. The momentum distribution of the spectator protons follows the impulse approximation very well. Four-momentum transfers q to the target nucleon are low, peaking at $q^2 \sim 3m_\pi{}^2$. The $\bar{p}\pi^-$ effective masses show a typical 3/2,3/2 isobar distribution; 80% of the events lie within ±70 MeV of the peak. Angular distributions of isobar decays are in reasonable agreement with the Treiman-Yang test for consistency with one-pion exchange.(1) The ratio, R, of the cross section observed for producing the anti-isobar to the cross section observed for producing the 3/2,3/2 isobar ($p\pi^+$) in pp collisions at the same energy is $R<1/4$. If the $\bar{p}n$ interactions involved only one-pion exchange, $R \approx 1/2$ would be expected. It is suggested that the difference may be due to competition from $\bar{p}n$ annihilations, along the lines discussed by Durand and Chiu for double pion production in $\bar{p}p$ interactions.(2)

Study of 6 Prong Events Produced By 3.2 and 3.5 BeV/c π^+ in Hydrogen

D. D. Carmony, D. N. Hoa, R. L. Lander, C. Rindfleisch, and Ng. H. Xuong

Physics Department
UNIVERSITY OF CALIFORNIA, SAN DIEGO

We have measured about 900 six prong events produced by 3.2 and 3.5 BeV/c π^+ in the 20" Hydrogen Bubble Chamber. We found:

389 Events of the type $\pi^+ p \rightarrow p\, \pi^+\, \pi^+\, \pi^+\, \pi^-\, \pi^-$ (1)

240 Events of the type $\pi^+ p \rightarrow p\, \pi^+\, \pi^+\, \pi^+\, \pi^-\, \pi^-\, \pi^0$ (2)

35 Events of the type $\pi^+ p \rightarrow \pi^+\, \pi^+\, \pi^+\, \pi^+\, \pi^-\, \pi^-\, n$ (3)

The cross section at 3.5 BeV/c for reaction (1), (2), and (3) are 165 ± 40 μb; 104 ± 25 μb; 22 ± 7 μb. About 50 events of reaction (2) are from the reaction:

$\pi^+ p \rightarrow p\, \pi^+\, \pi^+\, \pi^-\, \eta^0$ with $\eta \rightarrow \pi^+\, \pi^-\, \pi^0$ (4)

(σ = 26 ± 9 μb at 3.5 BeV/c)

An indication of the reported $\eta\, \pi^+\, \pi^-$ resonance at 960 MeV is observed but needs more study. Also, all various invariant mass distribution is under investigation.

The production of eta zero mesons in π^- P collisions

Authors: F. Bulos, R.E. Lanou, A.E. Pifer, A.M. Shapiro, M. Widgoff, Brown University
R. Panvini, Brandeis University
L. Guerriero, G. Calvelli, G.A. Salandin, A. Tomasin, L. Ventura, C. Voci, F. Waldner, Padua University
C.A. Bordner, A.E. Brenner, M.E. Law, E.E. Ronat, K. Strauch, J.J. Szymanski, Harvard University
P. Bastien, B.B. Brabson, Y. Eisenberg[+], B.T. Feld, V.K. Fischer, I.A. Pless, L. Rosenson, and R.K. Yamamoto, M.I.T.

Abstract: The excitation function and angular distributions for the process $\pi^- + P \rightarrow \eta^o + N$ have been studied at several incident pion kinetic energies. The energies are 545, 588, 619, 659, 755, 827, 878, 916, 1003, and 1158 Mev. The eta zero meson is detected via its two gamma decay mode by means of converting these gamma rays in a iron plate spark chamber array. The angular distributions of the eta are then determined from the observed direction of the bisector of the angle between the two gamma rays of the eta. The preliminary angular distributions which result are consistent with S wave production although some P wave appears to be needed slightly above threshold. The momentum dependence of the cross section for the process $\pi^- + P \rightarrow \eta^o + N$ (where $\eta^o \rightarrow \gamma + \gamma$) is also consistent with S wave production. Specifically the cross section at an eta momentum (in the πp center of mass) of 22 Mev/c is 0.53 $\pm$ 0.06 millibarns and at 47 Mev/c it is 1.15 $\pm$ 0.1 millibarns. At higher momenta the cross section decreases from this value. This result is based upon a sample containing approximately 100 eta events at each pion energy and represents the first one fifth of the available sample. Results from a larger fraction of the sample will be presented at the meeting.

РОЖДЕНИЕ МЕДЛЕННЫХ π-МЕЗОНОВ НА ЛЕГКИХ ЯДРАХ И ИНТЕРПРЕТАЦИЯ АВС-АНОМАЛИИ КАК СЛЕДСТВИЕ $\pi\pi$-РЕЗОНАНСА С МАССОЙ $M \simeq 275$ Мэв

Г.С.Веселовский, А.Ф.Грашин, В.С.Демидов, Е.В.Кузнецов, Е.П.Кузнецов, А.К.Поносов, В.П.Протасов, А.В.Самойлов, Ф.М.Сергеев, Я.Я.Шаламов
Институт теоретической и экспериментальной физики, Москва, СССР

Данная работа предпринята с целью поисков возможных резонансов в П-П - системе при $Q \lesssim \mu$, где Q -кинетическая энергия П-мезонов в их системе центра инерции, μ -масса П-мезона.

Экспериментальные данные были получены с помощью 17-литровой и 200-литровой фреоновых пузырьковых камер ИТЭФ, экспонированных на пучках Π^-- мезонов с импульсом 2,8 Гэв/с на ускорителях ОИЯИ и ИТЭФ. При просмотре снимков отбирались взаимодействия, в которых два или более вторичных $\Pi^\pm$ - мезонов останавливаются в рабочем объеме камеры. Распределение по Q для пар Π^+ Π^- в области $Q \lesssim 20$ Мэв отличается от распределения для пар Π^+ Π^+ и Π^- Π^-.

Авторам удается объяснить данные по рождению Π^+ Π^- пар, а также полученные ранее результаты по АВС - аномалии в предположении, что существует узкий П П - резонанс с массой $M \simeq 275$ Мэв, шириной $\Gamma \lesssim 5$ Мэв и квантовыми числами 0^{++} ($T = 0$). При этом наблюдаемые Q -распределения пар Π^+ Π^- являются результатом интерференции брейт-вигнеровской и потенциальной амплитуд . Получено, что с вероятностью 0,99 масса лежит в интервале от 272-х до 276 Мэв.

Обработка данных по рождению $\Pi^+\Pi^+$ и Π^- Π^- - пар показывает, что энергетическое и угловое распределения хорошо описываются фазовыми кривыми с учетом эффекта тождественности (Бозе-симметризация). Других статистически обусловленных аномалий не обнаружено.

SLOW PION PRODUCTION ON LIGHT NUCLEI AND THE INTERPRETATION OF THE ABC-ANOMALY AS A RESULT OF $\pi\pi$-RESONANCE WITH A MASS M $\simeq$ 275 MEV

G.S.Veselovsky, A.F.Grashin, V.S.Demidov, E.V.Kuznetsov, E.P. Kuznetsov, A.K.Ponosov, V.P.Protasov, A.V.Samoilov, F.M.Sergeev, Ya.Ya.Shalamov

Institute of Theoretical and Experimental Physics, Moscow, USSR

The investigation was undertaken in order to search for possible di-pion resonances in the interval $Q \lesssim \mu$, where Q is the kinetic energy of pions in the barycentric di-pion system, μ is pion mass.

The experimental data were obtained by means of 17-liter and 200 - liter ITEP freon bubble chambers exposed to 2.8 GeV/c beams of JINR and ITEP accelerators. While scanning pictures we selected interactions when two or more produced $\pi^{\pm}$-mesons stopped in the fiducial volume of the chambers.

The Q-distribution for $\pi^+\pi^-$ pairs is different in the region $Q \lesssim 20$ MeV from the distribution for $\pi^+\pi^+$ and $\pi^-\pi^-$ pairs. The authors have succeeded in explaining $\pi^+\pi^-$ data as well as other results on the ABC-anomaly, assuming the existence of a narrow pion-pion resonance with a mass M $\simeq$ 275 MeV, the width $\Gamma \lesssim 5$ MeV and the quantum numbers 0^{++}. Experimental Q-distributions for $\pi^+\pi^-$ pairs arise from an interference between Breit-Wigner and potential amplitudes in this case. It was found that with a 99% confidence 272 < M < 276 MeV.

The treatment of the data on $\pi^+\pi^+$ and $\pi^-\pi^-$ pair production shows that energy and angular distributions may be described by phase space curves taking into account the Bose-symmetrisation effect. There are found no other statistically significant anomalies.

УШ

РЕЗОНАНСЫ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ

Эксперимент

STRANGE PARTICLE RESONANCES

Experimental

Ξ^{*} (1530-MeV) SPIN AND PARITY†

Janice Button-Shafer

Lawrence Radiation Laboratory
University of California
Berkeley, California, USA

The $\Xi^{-}\pi$ resonance at 1530 MeV has been studied in $\Xi K\pi$ and $\Xi K\pi\pi$ final states produced by K^{-}-p interactions at 2.45 to 2.7 BeV/c. Spin and parity determinations have been made by moment analysis. These will be compared with the work done by UCLA at 1.8 to 1.95 GeV/c, which assigned spin $\geq 3/2$ (spin 1/2 having a probability of $< 10^{-3}$) and positive parity for J = 3/2 (negative parity having a probability of 0.016).[1]

---

1. P. E. Schlein, D. D. Carmony, G. M. Pjerrou, W. E. Slater, D. H. Stork, and H. K. Ticho, Phys. Rev. Letters 11, 167 (1963).

VIII-2

Quantum Numbers of the $Y^*(1660)$

P.L. Connolly, E.L. Hart, D.C. Rahm,
D.L. Stonehill, B. Thevenet[+], W.J. Willis, S.S. Yamamoto
Brookhaven National Laboratory, L.I., New York, USA

We studied the reactions $K^- + p \rightarrow \Lambda + \pi^o$ and $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ at six energies near 1660 in the center of mass system. The observation of rapid variations in the angular distribution and polarization with energy allows conclusions to be drawn concerning the quantum numbers of the resonance. The second reaction seems to be dominated by the production and decay of the system $Y^{*\pm}(1385) + \pi^{\mp}$ in the state with T = 1. Consequently, the angular distributions in this reaction are useful in resolving some ambiguities remaining after the analysis of the two-body channels.

[+] On leave of absence from LPCHE, CEN Saclay.

K^--p Interactions, from 830 to 960 MeV/c*

G. R. Charlton, P. E. Condon, R. Uhlig, M. Whatley and G. B. Yodh

University of Maryland, College Park, Maryland, U.S.A.

A. Aitken, R. Glasser and A. J. Herz

U. S. Naval Research Laboratory, Washington, D. C., U.S.A.

The following reactions

$$K^- + p \rightarrow \Lambda + \pi^0$$

$$K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$$

$$K^- + p \rightarrow \bar{K}^0 + n$$

$$K^- + p \rightarrow \bar{K}^0 + p + \pi^-$$

are being studied in the 30" BNL hydrogen bubble chamber in a 13 kg field. Exposures were carried out at nominal momenta of 830, 880, 910, 740 and 960 MeV/c and a total of 180,000 pictures were taken with approximately 8 K^- per picture. Results based on some 3500 events will be presented.

K^- - p INTERACTION NEAR 1 BeV/c

Robert W. Birge, Robert Bell, Robert P.Ely, Jr.,
Sun-Yiu Fung, James Louie, and Jack Sahouria

Lawrence Radiation Laboratory, University of California,
Berkeley, California, USA

We are studying the K^--p interaction at 50 MeV/c intervals between 850 MeV/c and 1150 MeV/c with pictures taken in the new 25-inch hydrogen bubble chamber at the Lawrence Radiation Laboratory. Angular distributions are being studied throughout this region to verify the quantum numbers of the 1815 MeV resonance and the possible existence of the 1765 MeV resonance.

The Reaction $K^- + p \rightarrow \Sigma\pi\pi$ at 1.34 BeV/c

W. P. Swanson, J. R. Ficenec, R. I. Hulsizer, and W. P. Trower
Physics Department, University of Illinois, Urbana, Illinois

Participant who will present paper - E. L. Goldwasser

This paper describes the second phase of the experiment described in the previous abstract. The reactions studied are:

$$K^- + p \rightarrow \Sigma^- + \pi^+ + \pi^o \qquad \text{(146 events)} \qquad (1)$$

$$\Sigma^+ + \pi^- + \pi^o \qquad \text{(151 events)} \qquad (2)$$

We see evidence for Y_o^* (1405) and Y_o^*(1520) production in these reactions. We are determining the mean values of the masses, the partial cross sections, and the decay properties of the resonances. More measurements are currently being made in order to reduce the statistical fluctuations in the mass plots. An attempt will then be made to observe the more weakly-produced resonances. A comparison with the results of other experiments at nearby energies[1] will be made.

[1] M. H. Alston, et al., Proc. Intern. Conf. High Energy Physics, CERN, 311(1962); W. A. Cooper, et al., Proc. Intern. Conf. High Energy Physics, CERN, 298(1962); Barbaro-Galtieri, et al., Bull. Am. Phys. Soc., Ser. II, 9, 23(1964), and private communication.

PRODUCTION OF S=0, -1 RESONANT STATES IN K^- p INTERACTIONS AT 2.45 GeV/c

Luis W., Alvarez, Angela Barbaro-Galtieri, Janice Button-Shafer Shafer, Orin I, Dahl, Jerome Friedman, Stanley Flatte, Philippe Eberhard, William E. Humphery, George R., Kalbfleisch, James S. Lindsey, Deane W.Merrill, Joseph J. Murray, Alan Rittenberg, Ronald R.Ross, Frank T. Shively, Daniel M. Siegel, Gerald A. Smith, and Robert D.Tripp

Department of Physics and Lawrence Radiation Laboratory
University of Caliofrnia, Berkeley, California, USA

About 70 000 pictures of 2.45 - GeV/c K^- p interactions have been obtained in the present 72-inch hydrogen bubble-chamber experiment. Each picture contains six or seven negative K mesons incident on hydrogen, which yields a total pathlength of ~ 2 events/μbarn. The π^- contamination is one or two π^- per picture. Approximately 15 000 events of all topologies except 1-, 2-, and 3-prong events have been measured and remeasured. Effective mass distributions of two or more particles in the final state show production of resonant states to be an important contribution to cross section. Cross sections and angular distributions for production of some of the known meson and baryon resonances are reported.

PRODUCTION OF Ξ K (n)π, ΛKK(n)π AND $\Sigma K\bar{K}$ FINAL STATES IN K^- -p INTERACTIONS AT 2.45 TO 2.70 GEV/c

Gerald A. Smith, James S.Lindsey and Joseph J. Murray

Lawrence Radiation Laboratory
University of California
Berkeley, California,
U S A

The 72-inch hydrogen bubble chamber has been exposed to a separated beam of K^- mesons at incident momenta of 2.45, 2.64 and 2.70 GeV/c. Approximately 475 000 pictures with 6 to 7 K^- and i to 2π^- per picture have been taken in the approximate ratio i : i : 3 : 2 at each of the respective momenta . Scanning and measuring of $\Sigma K\pi$, $\Sigma K\pi\pi$, $\Lambda K\bar{K}$, $\Lambda K\bar{K}\pi$ and $\Sigma K\bar{K}$ reactions have yielded 518, 85, 426, 26 and 31 events, respectively. These numbers represent approximately two-thirds of the total available data. Production of Ξ^*(1530 MeV), ϕ(1020 m MeV) and K^*(1890 MeV) is observed in these events over this range of momenta. A detailed discussion of the dominant characteristics of these reactions and the possible existence of new strangeness -2 baryon states of mass less than 2 GeV is presented.

Resonance Production in the Reaction $K^- p \rightarrow K^- p \pi^+\pi^-$ at 2.63 and 2.70 BeV/c

M. Pripstein, J. R. Ficenec, R. I. Hulsizer, D. W. Mortara, W. P. Swanson, and W. P. Trower

Physics Department, University of Illinois, Urbana, Illinois

We report here results on the reaction $K^- p \rightarrow K^- p \pi^+\pi^-$ at 2.63 and 2.70 BeV/c, based on a study of approximately 60,000 pictures of K^--p interactions in the Berkeley 72-in. liquid hydrogen bubble chamber. Events having a 4-prong topology were measured with an SMP on line with the University of Illinois CSX-1 computer. The analysis indicates that the reaction $K^- p \rightarrow K^- p \pi^+\pi^-$ is produced primarily via a three-body intermediate state, as follows:

$$K^- + p \rightarrow \left\{ \begin{matrix} K^{0*} + \pi^- + p \\ K^- + \pi^- + N^*_{33}\ (1238) \end{matrix} \right\} \rightarrow K^- + p + \pi^+ + \pi^-,$$

with the production of the K* and N^*_{33} resonances peaked at low momentum transfers. Decay distributions of these resonances will be presented and production mechanisms of these resonances will be discussed. The effective-mass plot of the (K^-,p) system indicates the presence of some Y^*_0 (1815) with a full-width-at-half-maximum of the order of 60 MeV.

The Reactions $K^- + p \rightarrow \Sigma^{\pm} + 3\pi$ and $\Sigma^{\pm} + 4\pi$ at 2.63 and 2.70 BeV/c

R. I. Hulsizer, J. R. Ficenec, D. W. Mortara, M. Pripstein, W. P. Swanson, and W. P. Trower

Physics Department, University of Illinois, Urbana, Illinois

We are investigating the ($\Sigma^{\pm} - 3\pi$) and ($\Sigma^{\pm} - 4\pi$) final states produced in the Berkeley 72-inch liquid-hydrogen bubble chamber by incident K^- beams of 2.63 and 2.70 BeV/c momenta. Approximately 114,000 pictures in all are being analyzed. The effective-mass plots of the ($\Sigma^{\pm} \pi^{\mp}$) system in the above final states show peaks corresponding to the $Y_0^*(1405)$ and $Y_0^*(1520)$ resonances. Data on the production and decay distributions of these resonances will be presented.

VIII-IO

K^- p INTERACTION AT 3 Gev/c

Final states with more than one strange particles

R. Barloutaud, A. Levêque, J. Meyer, P. Schlein, A. Verglas

C.E.A. Saclay

E.S. Gelsema J.C. Kluyver, A.G. Tenner

Zeeman Laboratorium, Amsterdam.

J. Badier, M. Demoulin, J. Goldberg, B.P. Gregory,
P. Krejbich, C. Pelletier, M. Ville

Ecole Polytechnique, Paris.

300 000 pictures with 10 K^- taken at the CERN P.S. with the Saclay 81 cm hydrogen chamber were scanned for events showing decay of more than one strange particle. We report results on the search for strangeness - 2 baryonic resonances and on the production features of bosons decaying into strange particles.

HYPERON PRODUCTION IN K^- - p INTERACTIONS AT 3.0 GEV/c

E.S.Gelesma, J.C.Kluyver, A.G.Tenner
S Zeeman Laboratorium,
Amsterdam

J.Badier, M.Demoulin, J.Golberg, B.P.Gregory, P.Krejbich,
C.Pelletier, M.Ville
Ecole Polytechnique, Paris
R.Barloutaud, M.Leveque, J.Meyer, A.Verglas
Laboratoire de Physique Corpusculaire à Haute Energie,
CEN - Saclay

Results on reactions producing a Λ or Σ will be discussed. The invariant mass spectra in 3, 4 and 5 body reactions have been studied and the results of a search for baryon and boson resonances will be given. Evidence for the production of resonances in 2-body processes will be presented.

HYPERON RESONANCES IN 3.5 GeV/c K^--PROTON INTERACTIONS

Bubble chamber film analysis groups of Birmingham and Glasgow Universities, Imperial College London, Oxford University and Rutherford Laboratory

Production of Ξ Hyperons by 5 Bev/c K^- Mesons

V.E. Barnes, B.B. Culwick, J.L. Lloyd, R.B. Palmer,
D. Radojicic, C.R. Richardson, N.P. Samios, J.R. Smith

Brookhaven National Laboratory
Upton, N.Y.

and

M. Goldberg, B. Goz, M. Gundzik, N. Horwitz,
J.Leitner, M.Primer, R. Wolfe

Syracuse University
Syracuse, N.Y.

The Brookhaven National Laboratory 80" liquid hydrogen bubble chamber has been exposed to a mass-separated beam of 5.0 Bev/c K^- mesons at the Brookhaven AGS. An analysis of the first 100,000 pictures shows that the total sample of the film should contain about 300 cases of Ξ^- and Ξ^0 hyperon production. The K^- beam path length is such that one obtains 5 events of a given kind per microbarn of K^- -p interaction cross section.

The observed Ξ hyperons are produced in association with 2, 3 or 4 mesons, the effective mass of the hyperon-meson system ranging up to 3.18 Bev/c^2. Results of a detailed analysis of the total sample of events will be presented.

HYPERON PRODUCTION BY 3 AND 3.5 GEV/c K^+

M.Ferro-Luzzi, R.George, Y.Goldschmidt-Clermont,
V.P.Henri, B.Jongejans, D.W.G.Leith, G.Lynch, F.Muller,
and J.M.Perreau

CERN, Geneva, Switzerland

Results will be presented on reactions of the type $K^+ p \rightarrow K K Y$ ($Y = \Lambda, \Sigma$) and $K^+ p \rightarrow K K Y \pi$, at incident K^+ lab.momenta of 3 and 3.5 GeV/c. A study of the effective-mass spectra, in particular for the $S = +2$ KYK system, will be presented, together with cross sections and angular distributions.

($KN\pi\pi\pi$) FINAL STATES IN INTERACTIONS OF 3.0 GeV/c K^+

M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V.P. Henri, B. Jongejans, D.W.G. Leith, G. Lynch, F. Muller and J.-M. Perreau

CERN , Geneva , Switzerland

A study of the 5-body final states in K^+p collisions at 3.0 GeV/c will be presented. About 700 events have been processed and identified as belonging to the following reactions:

$$K^+p \longrightarrow K^+p\pi^+\pi^-\pi^0 \qquad (1)$$

$$K^0p\pi^+\pi^+\pi^- \qquad (2)$$

The cross-sections and production of resonances in these reactions will be discussed. In particular, we will comment on the production of $K^*(725)$, and enhancements in the ($K\pi\pi$) system.

K^+-D INTERACTIONS AT 2.3 BeV/c

John L. Brown, Gerson Goldhaber, Sulamith Goldhaber,
Allan A. Hirata, John A. Kadyk, Thomas A. O'Halloran,
George H. Trilling, and Benjamin C. Shen

(Presented by Sulamith Goldhaber)

Lawrence Radiation Laboratory
University of California
Berkeley, California, U S A

Interactions of K^+ mesons with protons and neutrons in deuterium are being studied. In particular, we will report the results of a comparison of the reactions

$$\text{(a)} \quad K^+ + p\,(n) \longrightarrow K^{*+} + p + (n)$$

and

$$\text{(b)} \quad K^+ + n\,(p) \longrightarrow K^{*0} + p + (p)\,.$$

The particles in brackets are considered as spectators. It is of interest to note that whereas in a peripheral collision, reaction (a) proceeds via isoscalar or isovector exchange, reaction (b) can proceed only via an isovector exchange. Limits on the cross section for associated production by K mesons will be presented as well as studies on invariant masses in the four- and five-particle final state.

УШ-17

ИССЛЕДОВАНИЕ ПАР $K\tilde{K}$, ГЕНЕРИРОВАННЫХ π^--МЕЗОНАМИ С ИМПУЛЬСОМ 2,8 Бэв/с [x/].

В.В.Бармин, А.Г.Долголенко, И.А.Ерофеев, Ю.С.Крестников, А.Г. Мешковский, Г.Д.Тихомиров, Ю.В.Требуховский, В.А. Шебанов.

Институт теоретической и экспериментальной физики
Москва, С С С Р

Изучалось рождение пар $K^0\tilde{K}^0$ и $K^0K^-\pi^+$-мезонами с импульсом 2,8 Бэв/с на ядрах H, C, Xe в пропанксеноновой пузырьковой камере. На распределении эффективных масс системы $K^0\tilde{K}^0$ отчетливо выделяется пик при $M_{(K^0\tilde{K}^0)}$ = 1280 Мэв с шириной около 100 Мэв. Обсуждается возможность интерпретации этого пика на основе распада $f^0 \to K_1^0 + K_1^0$

---

x/ Данная работа имеет отношение и к секции УП.

AN INVESTIGATION OF $K\tilde{K}$ PAIR-PRODUCTION REACTION* BY π^--MESONS WITH MOMENTA 2.8 BeV/c

V.V.Barmin, A.G.Dolgolenko, I.A.Erofeev,
Yu.S.Krestnikov, A.G.Meshkovsky, G.D.Tikhomirov,
Yu.V.Trebukhovsky, V.A.Shebanov

Institute of Theoretical and Experimental Physics
Moscow, U S S R

The $K^0\tilde{K}^0$ and K^0K^- pair- production reaction at 2.8 BeV/c was studied on H.C.Xe nucleons with propan-xenon bubble chamber. The distribution of effective masses $K\tilde{K}$ has a noticeable bump at M $(K^0\tilde{K}^0)$ = 1280 MeV and $\Gamma \simeq 100$ MeV. A feasible interpretation of this bump as $f^0 \rightarrow K_1^0 + \tilde{K}_1^0$ decay is discussed.

---

* This paper is also related to Section YII.

STRANGE PARTICLE PRODUCTION BY 3 BEV/c MESONS IN HYDROGEN

T.P.Wangler, A.R.Erwin, and W.D.Walker
University of Wisconsin, Madison, Wisconsin, USA

From an analysis of 60 000 pictures of π^-p interactions at a pion momentum of 3 BeV/c in a hydrogen bubble chamber, over 600 events were identified as strange particle events. Reactions involving two strange particles and as many as four pions were identified on the basis of both kinematical fitting and bubble density information.

The center of mass angular distributions usually show the familiar backward tendency for the baryons and a forward tendency for K mesons. Invariant mass distributions show the production of several resonant states including the Y_1^* (1385 MeV), K^* (885 MeV) and Y_o^* (1405 MeV). The two body reactions

$$\pi^- + p \rightarrow K^* + Y_1^*$$
$$\rightarrow K^* + Y_o^*$$

are also reported and studied.

Evidence is presented for a possible new resonance in the Kπ system at a mass of 1175 MeV.

The two, three, and four particle reactions are discussed and an attempt is made to put limits on the Unitary Symmetry multiplet of the f^o from the number of $K_1^o K_1^o$ events with a mass near the f^o.

The cross sections for the various reactions are calculated and the total strange particle cross section at this energy is estimated to be

$$\sigma = 1.682 \text{ mb} \pm .199 \text{ mb}.$$

PRODUCTION OF STRANGE-PARTICLE RESONANT STATES IN π^- + p INTERACTIONS AT 3.2 AND 4.2 BeV/c*

Suh Urk Chung, Orin I. Dahl, Lyndon M. Hardy, Richard I. Hess, Janos Kirz, and Donald H. Miller

Lawrence Radiation Laboratory
University of California
Berkeley, California, USA

The correlations in $Y\pi K$ and $Y\pi\pi K$ final states have been studied with good statistical accuracy. We find that $Y\pi K$ events are produced predominantly through the YK^* intermediate state, although much evidence for structure in the $Y\pi$ system persists. Baryon resonances that can be produced by boson exchange are particularly copious, although some production of $\Sigma^- K^{*+}$ and $Y_1^{*-} K^+$ are observed. Examination of the $Y\pi\pi K$ events indicates that most production occurs through $Y^* K^*$, again in charge configurations that are accessible through boson exchange.

УШ-20

ИЗУЧЕНИЕ РЕЗОНАНСОВ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ В πp ВЗАИМОДЕЙСТВИЯХ ПРИ 4,0 ГЭВ/С

Б.П.Банник, Э.Г.Бубелев, Ким Хи Ин,
А.А.Кузнецов, Н.Н.Мельникова, Г.Л.Резвая,
Б.Чадра

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

В работе исследуются мезонные и барионные резонансы с участием странных частиц, на материале полученном с помощью 24-литровой пропановой пузырьковой камеры в пучке Π^- -мезонов с импульсом 4,0 Гэв/с; даются оценки сечений рождения известных гиперон-пионных, и мезон-пионных резонансов при данном импульсе. Обсуждается возможность радиационных распадов резонансов.

INVESTIGATION OF STRANGE PARTICLES RESONANT STATES IN π^-p INTERACTION AT 4.0 BeV/c

B.P.Bannik, E.G.Bubelev, Kim Hi In, A.A.Kusnetsov,
N.N.Melnikova, G.L.Resvaja, B.Chadra

Joint Institute for Nuclear Research
Dubna, USSR

Resonant states with mesons, baryons and strange particles on films obtained at the 24 l . propan bubble chamber irradiated in π^- beam of 4 BeV/c are investigated. Production cross sections of the known pion-hyperon and meson-pion resonances are evaluated.

The possible radiative decays of resonances are investigated.

A Study of $\pi^- + P \rightarrow K_1^o + K_1^o + n$ Reaction at 6 Bev/c

V.E. Barnes, W.B. Fowler, K.W. Lai, D. Radojicic,
D.C. Rahm, M.S. Webster
Brookhaven National Laboratory
Upton, L.I.,N.Y.

A total of 60,000 pictures have been obtained in an exposure of the BNL 80-inch hydrogen bubble chamber to a 6 Bev/c negative pion beam at the AGS. A study of the effective mass spectra of (K_1^o, K_1^o), $(K_1^o\ n)$ and the angular distribution of recoil nucleons in $\pi^- + p \rightarrow K_1^o + K_1^o + n$ reaction will be presented. Possible production mechanisms will also be discussed.

УШ-22

ИССЛЕДОВАНИЕ РЕЗОНАНСОВ СТРАННЫХ ЧАСТИЦ И ПИОНОВ, РОЖДЕННЫХ В Π^- p-ВЗАИМОДЕЙСТВИЯХ ПРИ 7,5 ГЭВ.

В.А.Беляков, В.И.Векслер, Н.М.Вирясов,
Е.Н.Кладницкая, Г.И.Копылов, В.Н. Пенев,
М.И. Соловьев.

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

В работе исследуется образование в П-р - взаимодействиях при 7,5 Гэв резонансов, распадающихся на Λ -гипероны и П-мезоны, а также на K^0 - мезоны и пионы.

Обнаружено рождение резонансов $Y_1^{*\pm}$ (I385), Y_1^* (I660), K^*(888), K^* (730). Сделана оценка сечения рождения этих резонансов на водороде пионами нашей энергии.

Подробно исследуется резонанс Y_1^{*+} (I385). Обсуждаются максимумы в спектрах эффективных масс ($\Lambda\,\Pi^+\,\Pi^-$) и (К ЗП) - систем.

STUDY OF STRANGE PARTICLE-PION RESONANCES GENERATED IN $\pi^- p$ INTERACTIONS AT 7.5 GeV

V.A.Belyakov, V.I.Veksler, N.M.Viryasov, E.N.Kladnitskaya,
G.I.Kopylov, V.N.Penev, M.I.Soloviev

Joint Institute for Nuclear Research
Dubna, USSR

The production of resonances which decay into Λ - hyperon-pions and K^0- pions has been investigated. The creation $Y_1^{*\pm}(1385)$, $Y_1^*(1660)$, $K^*(880)$, $K^*(730)$ was observed. Estimates for cross sections of generation of these resonances in hydrogen by 7.5 GeV negative pions are given.

The resonance $Y_1^{*\pm}(1385)$ is investigated in details. The maxima appeared in effective mass distributions of $(\Lambda\pi^+\pi^-)$ and $(K^0\pi^-)$ systems are discussed.

УШ-23

ИЗУЧЕНИЕ ΛK^+ И K^0K^--ПАР, РОЖДЕННЫХ В Π^-p - ВЗАИМОДЕЙСТВИЯХ ПРИ 7,5 ГЭВ/С

В.А.Беляков, Н.М.Вирясов, Е.Н.Кладницкая,
В.Н.Пенев, Е.С.Соколова, М.И.Соловьев

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

Изучалось парное рождение странных частиц ΛK^+ и K^0K^-, генерированных в Π^-p-взаимодействиях при 7,5 Гэв/с. Приводятся угловые и импульсные распределения странных частиц в с.ц.м. рождения. Обсуждаются распределения эффективных масс ΛK^+ и K^0K^--пар. В распределении по M для K^0K^--пар обнаруживается пик резонансного характера с массой 1060 Мэв и $\Gamma/2$ = 30 Мэв. Для K^+-пар резонансных пиков не обнаружено.

STUDY OF ΛK^+ AND K^0K^+ - PAIRS PRODUCED IN π^-p INTERACTIONS AT 7.5 GeV/c

V.A.Belyakov, N.M.Viryasov, E.N.Kladnitskaya, V.N.Penev,
E.S.Sokolova, M.I.Soloivev

Joint Institute for Nuclear Research
Dubna,USSR

The ΛK^+ and K^0K^- - pair production has been investigated. The angular and momentum distributions of strange particles in the centre of mass system are given. The effective mass distributions ΛK^+ and K^0K^- - pairs are discussed. It was found that the effective mass distribution for K^0K^- - pairs has a peak at 1060 MeV with $\Gamma/2$ = 30 MeV. The effective mass distribution of ΛK^+ - pairs does not show any peak of a resonance type.

Production of Strange Particles in π^+ - p Collisions at 1.39, 1.76, and 2.08 GeV/c*

H. W. J. Foelsche, H. L. Kraybill, C. Y. Chien, and A. Lopez-Cepero
Yale University
(to be presented by H. D. Taft)

We have identified 668 two-pronged reactions producing strange particles at π^+p momenta of 1.39, 1.76, and 2.08 GeV/c. The angular distributions of the reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ will be presented. Production of the Y_1^* at 1385 MeV is observed at 1.76 and 2.08 GeV/c, in the reaction $\pi^+ + p \rightarrow \Lambda^o + K^+ + \pi^+$, with very low background. The width of the Y_1^* at these two energies was determined to be $32 \pm \frac{7}{6}$ MeV and $26 \pm \frac{8}{6}$ MeV, respectively. Cross-sections for reactions producing $\Sigma^+K^+\pi^o$, $\Sigma^oK^+\pi^+$ are consistent with charge independence. The K*(885 MeV) is observed in the reactions producing $\Sigma^+K^+\pi^o$ and $\Sigma^+\pi^+K^o$. No definite evidence of other resonances has been found. Partial cross-sections will be given for each energy. Decay angular distributions of the Y_1^* will be presented.

EXPERIMENTAL RESULTS ON THE ANNIHILATIONS $\bar{p}p \rightarrow K+K+2\pi$ AT REST

R. Armenteros, D.N. Edwards[+], T. Jacobsen, L. Montanet, A. Shapira[++] and J. Vandermeulen,

CERN

Ch. d'Andlau, A. Astier, P. Baillon, J. Cohen-Ganouna, C. Defoix, J. Siaud, C. Ghesquière and P. Rivet,

Laboratoire de Physique Nucléaire,

Collège de France, Paris

The evidence for C^o resonance will be discussed.

In addition to the 700 events of the type

$$\bar{p}p \rightarrow K_1^o K_1^o \pi^+\pi^- ,$$

the results of the analysis of which have already been published (Physics Letters Vol.9, p.207, 1964), the analysis results of about 2000 events of the type

$$\bar{p}p \rightarrow K_1^o (K^o)\pi^+\pi^- ,$$

and about the same number of events of the type

$$\bar{p}p \rightarrow K_1^o K^\pm \pi^\mp\pi^o ,$$ will be presented.

+ On leave of absence from Liverpool University

++ Ford Foundation Fellow - Now at Weizmann Institute, Rehovoth

Exp. Results on the annihilations $\bar{p}\,p \longrightarrow K\,K\,3\,\pi$ at rest

R. Armenteros, D.N. Edwards[+], T. Jacobsen, L. Montanet, A. Shapira[++] and J. Vandermeulen
CERN

Ch. d'Andlau, A. Astier, P. Baillon, J. Cohen-Ganouna, C. Defoix,
J. Siaud, C. Ghesquière and P. Rivet
Laboratoire de Physique Nucléaire,
Collège de France, Paris

About 350 events of the type

$$\bar{p}\,p \longrightarrow K_1^0\,K^-\,\pi^+\,\bar{\pi}\,\pi^+\,\pi^-$$

have been analyzed. The evidence for the $K\,K\,\pi$ resonance and details on its decay mode will be presented.

[+] On leave of absence from Liverpool University

[++] Ford Foundation Fellow. Now at Weizmann Institute, Rehovoth

ANNIHILATION OF 3 GEV/C ANTI-PROTONS INTO $K\bar{K}+m\pi$

Birmingham, CERN, Ecole Polytechnique, Imperial College, Saclay

---

We have studied the annihilations in hydrogen of antiprotons of 3 GeV/c momentum leading to the final states $K\bar{K}+m\pi$ where m=1, 2, 3 or 4.

Results will be presented on the following aspects :

a) cross-sections

b) invariant mass distributions

c) angular distributions of particles and resonances

d) estimates for resonance production in the different final states.

K Meson Production in $\bar{p}p$ Annihilations at 3.69 Bev/c*

C. Baltay, J. Lach, J. Sandweiss†, H. Taft, and N. Yeh
Yale University
and
D. J. Crennell, Y. Oren, C. R. Richardson, D. L. Stonehill, and R. Stump‡
Brookhaven National Laboratory

250,000 photographs of the BNL 20" Liquid Hydrogen Bubble Chamber exposed to an electrostatically purified beam of 3.69 Bev/c antiprotons at the BNL A.G.S. have been searched for annihilations into K mesons and pions. Approximately 4000 cases were found with 0, 2, or 4 charged prongs and one or two associated visible neutral K meson decays. Less than two percent of these events were annihilations into 4 K mesons with or without extra pions. No two-body K pairs without additional pions were found.

A systematic study of resonance production in these final states, and in particular a search for the recently reported[1-3] $KK\pi$ and $K\pi\pi$ resonances, is in progress and will be reported. Data on angular distributions and multiplicities of the kaons and pions will be presented.

† Alfred P. Sloan Foundation Fellow

‡ Present address: CERN, Geneva, Switzerland

1. R. Armenteros et. al., The Sienna International Conference on Elementary Particles, 1963.
2. R. Armenteros et. al., Bull. Am. Phys. Soc. Volume 9, 459 (1964).
3. T. H. Tan, D. Miller, and J. Steinberger, Bull. Am. Phys. Soc. Volume 9, 459 (1964).

HYPERON-ANTIHYPERON PRODUCTION BY 5.7 GEV/C ANTIPROTONS IN HYDROGEN

CERN and Saclay Collaboration

Results on hyperon-antihyperon production by antiprotons of 5.7 GeV/c momentum in hydrogen will be presented. These will include :

a) cross-section and production angular distributions for 2, 3, 4 and 5 body final states

b) effective mass distributions for the 3 and 4 body final states.

Y^* Production by 7 Bev/c Antiprotons in Hydrogen*

C. Baltay, C. Y. Chien, J. Lach, J. Sandweiss†, and H. Taft
Yale University
and
J. K. Kopp, Y. Oren, A. M. Thorndike, and M. S. Webster
Brookhaven National Laboratory

A new exposure has been made using the BNL 80 inch liquid hydrogen bubble chamber in an electrostatically separated 7 Bev/c $\bar{p}$ beam[1] at the Brookhaven A.G.S. A total of 10^6 meters of path length has been examined for the final states

$$\Lambda\bar{\Lambda}\pi^+\pi^-,\ \bar{\Lambda}\Sigma^+\pi^-\ \text{and c.c.},\ \bar{\Lambda}\bar{K}N \text{ and c.c.},\ \Lambda\bar{\Lambda}\pi^0.$$

A systematic investigation of resonance production of the form $\bar{Y}Y^*$, $Y\bar{Y}^*$ or $Y^*\bar{Y}^*$ has been made and results will be presented.

In studies of hyperon resonance production by 3.7 Bev/c antiprotons[2,3] many features of these reactions may be understood on the basis of single particle exchange models. More stringent tests of these models may be obtained through a detailed comparison of predictions for resonance production at higher energy with the data of this experiment. The results of such a comparison will be discussed.

† Alfred P. Sloan Foundation Fellow

1. I. Skillicorn and M. S. Webster; Status Report on a High Energy Separated Beam for the 80" Chamber. BNL Internal Report H-10.
2. C. Baltay, J. Sandweiss, H. Taft, B. B. Culwick, W. B. Fowler, J. F. Kopp, R. I. Louttit, J. R. Sanford, R. P. Shutt, A. M. Thorndike, and M. S. Webster; Production of Hyperon Resonances in $\Lambda\bar{\Lambda}\pi^+\pi^-$ Final States. Phys. Rev. Letters 11, 32 (1963).
3. C. Baltay, J. Sandweiss, H. D. Taft, B. B. Culwick, W. B. Fowler, J. K. Kopp, R. I. Louttit, J. R. Sanford, R. P. Shutt, D. L. Stonehill, A. M. Thorndike, and M. S. Webster; Investigation of Y^* and $\bar{Y}^*$ Production in Reactions of the Type $\bar{p} + p \to Y + \bar{Y} + \pi$; Phys. Rev. Letters 11, 346 (1963).

УШ-31

ИЗУЧЕНИЕ РЕЗОНАНСОВ С УЧАСТИЕМ СТРАННЫХ ЧАСТИЦ В np - ВЗАИМОДЕЙСТВИЯХ

В.Ф. Вишневский, Ду Юань-цай, В.И. Мороз,
Никитин А.В., Ю.А.Троян, Цзян Шао-Цзюн,
Чжан Вэнь-юй, Б.А.Шахбазян, Янь У-гуан

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

В работе изучаются резонансы с участием странных частиц в np - взаимодействиях с помощью пузырьковой камеры, облученной нейтронами с импульсом до II Гэв/с.

Наряду с изучением свойств известных резонансов, возникающих в np - взаимодействиях, особое внимание уделяется поиску новых резонансов, распадающихся на два бариона, на два бариона и мезон и на барион и γ - квант.

INVESTIGATION OF RESONANCES WITH THE PARTICIPATION OF STRANGE PARTICLES IN n-p INTERACTION

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A., Chiang Shaochun, Chang W.Y., Shahbazian B.A., Yen Wu-kuang

Joint Institute for Nuclear Research
Dubna, USSR

In this work resonances involving strange particles are being investigated from the 14000 pictures taken from a propane bubble chamber which was irradiated with a neutron beam with momentum up to 11 GeV/c.

Alongside with the study of the properties of the known resonance induced by the n-p interaction, special attention is being directed to searching for new resonances which may decay e.g. into two baryons, into baryons and one meson, into one baryon and a gamma-quantum (or indirectly), etc.

УШ-32

ОБРАЗОВАНИЕ ПАР НЕЙТРАЛЬНЫХ СТРАННЫХ ЧАСТИЦ В НЕЙТРОН-НУКЛОННЫХ СТОЛКНОВЕНИЯХ ПРИ ИМПУЛЬСЕ НЕЙТРОНОВ ДО II БЭВ/С

В.Ф.Вишневский, Ду Юань-цай, В.И. Мороз,
А.В.Никитин, Ю.А.Троян, Цзян Шао-цзюн,
Чжан Вэнь-юй, Шахбазян Б.А., Янь У-гуан

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

С помощью пропановой пузырьковой камеры, облученной пучком нейтронов, изучаются реакции с образованием пар нейтральных странных частиц в нейтрон-нуклонных столкновениях. Получено I40000 снимков. На 40000 фотографиях найдено I50 V^0V^0 пар. Исследуются угловые и импульсные характеристики странных частиц.

В распределении по $M^{эф}_{\Lambda K}$ наблюдается пик в районе I650 ÷ I700 Мэв, который можно связать с резонансом Λ^0K^0 системы. Обсуждаются свойства этого резонанса.

Работа по увеличению статистики продолжается.

PRODUCTION OF PAIRS OF NEUTRAL STRANGE PARTICLES IN NEUTRON-NUCLEON COLLISIONS AT MOMENTUM UP TO 11 GeV/c

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A., Chiang Shaochun, Chang W.Y., Shahbazian B.A., Ven Wu-kuang

Joint Institute of Nuclear Research, Dubna, USSR

With the help of a propane bubble chamber exposed to a neutron beam, the reactions producing neutral strange particle pairs have been studied for the neutron-nucleon collisions. About 140000 pictures have been taken, and of the first 40000 pictures about 150 pairs (V^0V^0) have been found.

The angle and momentum characteristics of the strange particles are being investigated.

From the distribution of $M^{ef}_{\Lambda K}$ a peak at 1650-1700 MeV has been found, which may be related with a Λ^0K^0 resonant system. The kinematic properties of the strange particles in the peak will be presented and discussed.

Production of Resonances by 0.5-6 BeV γ-ray Interactions in Hydrogen

A 12" Hydrogen Bubble Chamber was exposed to a hardened 6 BeV Bremsstrahlung γ-ray beam at the Cambridge Electron Accelerator. An analysis based upon about 10% of the total number of pictures taken, shows a large production of the (3/2, 3/2) 1238-MeV pion-nucleon resonance in the interactions below 1.2 BeV and ρ-meson production in the high energy (about ~2 BeV) interactions. The production of both of these resonances, especially the ρ, is peripheral. The total observed cross-section for the production of 3, or more, charged prongs and strange particles is about 100 μb and appears constant with energy. The observed strange particles total cross section (for P_γ>2.0 BeV) is 10-20 μb. The strange particle events seem to be dominated by Y_1^* (1385 MeV) and Y_0^* (1520 MeV) production. A complete account of the available data will be presented.

Authors: F. Bulos, R. E. Lanou, A. M. Shapiro, M. Widgoff (Brown University), A. Prodell (Brookhaven National Laboratory), G. E. Fischer (Cambridge Electron Accelerator), A. E. Brenner, M. E. Law, E. E. Ronat, K. Strauch, J. C. Street, J. J. Szymanski, J. D. Teal (Harvard University), P. Bastien, Y. Eisenberg, B. T. Feld, V. K. Fischer, L. Montanet, I. A. Pless, A. Rogers, C. Rogers, L. Rosenson, R. K. Yamamoto (Massachusetts Institute of Technology), L. Guerriero, G. A. Salandin, (Padua University).

STUDIES OF K^* PRODUCTION PROCESSES IN THE K^- + P REACTIONS AT 3 GEV/c

E.S.Gelsema, J.C.Kluyver, A.G.Tenner,
Zeeman Laboratorium, Amsterdam

J.Badier, M.Demoulin, J.Goldberg, B.P.Gregory, P.Krejbirch,
C.Pelletier, M.Ville
Ecole Polytechnique, Paris

R.Barloutaud, A.Leveque, J.Meyer, P.Schlein[+], A.Verglas,
Laboratoire de Physique Corpusculaire à Haute Energie, CEN-Saclay

The reaction $K^- + P \rightarrow K^{*-} + P \rightarrow K^0 + \pi^- + P$ has been studied at a beam mmomentum of 3.0 GeV/c. We have performed a moment analysis of the K^* decay distribution on a preliminary sample of 143 events produced in the 81 cm. Saclay hydrogen bubble chamber exposed to the separated K^- beam at CERN in order to a) verify the absence of "illegal" (i.e., parity non-conserving) moments in order that we may hypothesize that the K^* decays as a free particle and b) determine the density matrix elements of the K state from the "legal" moments. We find, in the language of GOTTFRIED and JACKSON[1] $\rho_{0,0} = (0.14+0.06)$, $\rho_{1,-1} = (0.34 + 0.05)$, and Re $(\rho_{1,0}) = (0.03 + 0.03)$. The observed forward peaking of the K^* production angular distribution and the satisfied requirement [1] $\mathrm{Re}(\rho_{1,0}) = 0$ indicate that the production process is compatible with the dominance of scalar and vector particle exchange diagrams. Since $\rho_{0,0}$ is a measure of the fractional contribution of scalar exchange, we see that vector exchange dominates the reaction to the extent of 86 + 6 %. Thses results are in excellent agreement with those of LYNCH et al. [2] in a study of the reaction $K^+ + P \rightarrow K^{*+} + P$ at the same energy. It may be remarked that if vector particle exchange dominates both the K^+ and K^- reactions, then charge conjugation invariance of the vertex $K^\pm + \rho^\circ \rightarrow K^{*\pm}$ requires that the density matrix elements observed in one reaction be identical with those observed in the other, as is indeed observed to be the case. Results of studies of the reaction $K^- + P \rightarrow K^* + N^*$ will also be presented.

[+] On leave from the University of California at Los Angeles.

1 K.Gotteried and J.D.Jackson, Physics Letters 8, 144 (1964).
R.W.Huff, preprint (1963).
S.M.Berman, R.J.Oakes, preprint (1964).

2 G.R.Lynch, M.Ferro-Luzzi, R.George, Y.Goldschmidt-Clermont, V.P.Henri, B.Jongejangs, D.W.G.Leith, F.Muller, J.M.Perreau, preprint (1964).

ПОИСКИ РАДИАЦИОННЫХ РАСПАДОВ РЕЗОНАНСОВ С УЧАСТИЕМ Λ - ГИПЕРОНОВ

Ван Юн-чан, Ким Хи Ин, Е.Н.Кладницкая,
Г.И.Копылов, А.А.Кузнецов, Н.Н.Мельникова,
Нгуен Дин Ты, Е.С.Соколова.

В настоящей работе приводятся предварительные данные по исследованию радиационных каналов распада резонансных систем с участием Λ -гиперонов. Получено указание о существовании не известного ранее резонанса в системе $\Lambda\eta^{\circ}$ с массой $\approx$ = 1680 Мэв или резонанса $\Lambda\gamma$ с массой $\approx$1340 Мэв.

VIII -35

SEARCH FOR RADIATIVE RESONANCE DECAYS INVOLVING Λ HYPERONS

Wang Yung-chang, Kim Hi In, E.N.Kladnitskaya,
G.I.Kopylov, A.A.Kuznetsov, N.N.Melnikova,
Nguyen Dinh-Tu, E.S.Sokolova

Joint Institute for Nuclear Research,
Dubna, USSR

Preliminary data on the radiative decays of the resonance systems involving Λ -hyperons are presented. An indication was obtained concerning the existence of the earlier unknown $\approx$ 1680 MeV $\Lambda\eta'$ resonance or a $\approx$ 1340 MeV $\Lambda\gamma$ resonance.

УIII-35

ПОИСКИ РАДИАЦИОННЫХ РАСПАДОВ РЕЗОНАНСОВ С УЧАСТИЕМ Λ - ГИПЕРОНОВ

Ван Юн-чан, Ким Хи Ин, Е.Н.Кладницкая,
Г.И.Копылов, А.А.Кузнецов, Н.Н.Мельникова,
Нгуен Дин Ты, Е.С.Соколова.

В настоящей работе приводятся предварительные данные по исследованию радиационных каналов распада резонансных систем с участием Λ -гиперонов. Получено указание о существовании не известного ранее резонанса в системе $\Lambda\eta^{\circ}$ с массой $\approx$ = I680 Мэв или резонанса $\Lambda\gamma$ с массой $\approx$ I340 Мэв.

PRELIMINARY RESULTS ON K^-- PROTON INTERACTIONS AT 6 GeV/c

Preliminary Chamber film analysis groups of
Birmingham and Glasgow Universities,
Imperial College London, Oxford University
and Rutherford Laboratory

K^- + p INTERACTIONS AT 3.5 GEV/c

M.Haque, D.Scotter, B.Musgrave

Department of Physics, University of Birmingham, Birmingham

W.Blair, A.Grant, I.S.Hughes, W.Morton, P.Negus, R.Turnbull

Department of Natural Philosophy, University of Glasgow, Glasgow

A.A.Z.Ahmad, S.Baker, L.Celnikier, A.Haque, S.Misbahuddin, H.J.Sherman, I.O.Skillicorn

Department of Physics, Imperial College, London

A.R.Atherton, G.B.Chadwick, W.T.Davies, J.H.Field, P.M.D.Gray, D.E.Lawrence, J.G.Loken, L.Lyons, J.H.Mulvey, A.Oxley, C.A.Wilkinson

Department of Nuclear Physics, University of Oxford

R.Elliott, C.M.Fisher, E.Pickup, L.K.Rangan, J.M.Scarr, E.C.Sedman, A.M.Segar

Rutherford High Energy Laboratory, Chilton, Berkshire

The Saclay 81 cm. hydrogen bubble chamber was operated in a beam of 3.46 GeV/c K^- mesons from the CERN P.S. The results of studies of the interactions produced are presented.

K^+ p INTERACTIONS AT 5.0 GeV/c

S.P.Almeida, H.W.Atherton, T.A.Byer, P.J.Dornan, A.G.Forson, J.H.Scharenguvel, D.M.Sendall, B.A.Westwood

Cambridge University, Cavendish Laboratory, England

The 81 cm Saclay hydrogen bubble chamber has been exposed to a separated K^+ beam of 5.0 GeV/c incident momentum. The reaction $K^+ + p \rightarrow K^+ + p + \pi^+ + \pi^-$ is being studied and the results obtained from a preliminary analysis of about 700 events are presented.

Some production and decay properties of observed resonances are discussed.

X

СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ

Теория

SYMMETRIES OF STRONG INTERACTIONS

Theoretical

СПИН И СИММЕТРИИ ВЗАИМОДЕЙСТВИЙ

В.И.Огиевецкий, И.В.Полубаринов

Объединенный институт ядерных исследований
Дубна, СССР

На основе неоднородной группы Лоренца введено понятие взаимодействующих полей с определенным спином. Дан перечень всех теорий векторных полей со спином I. В таких теориях

I. Пространственно-временное свойство векторных полей обладать спином I порождает симметрии, которые до сих пор казались не имеющими отношения к пространству-времени, например, симметрии, отвечающие сохранению электрического и барионного зарядов, изотопической и $SU(3)$- инвариантностям и т.д.

2. Векторные поля обязаны преобразовываться по регулярному представлению, так, что, например, существование 8 векторных бозонов говорит в пользу $SU(3)$ - инвариантности сильных взаимодействий, а девятый мезон можно связать с сохранением барионного числа;

3. Векторные поля с нулевым барионным зарядом должны иметь спин-четность I^- (в соответствии с опытом);

4. Константа взаимодействия неприводимого мультиплета векторных бозонов самого с собой и с другими полями универсальна;

Так как среди перечисленных теорий содержатся и теории Янга-Миллса, то данный подход позволил выяснить их смысл как теорий векторных полей со спином I и, кроме того, показал, что масса векторных полей не обязательно должна равняться нулю.

Построение теории нейтрального поля $h_{\mu\nu}$ со спином 2 взаимодействующего самого с собой и с другими полями, приводит к уравнениям, которые при массе 0 $h_{\mu\nu}$ совпадают с уравнениями Эйнштейна для гравитации. Существенно, что пространство-время при этом остается плоским, а нелинейности, свойственные теории Эйнштейна, порождаются требованием, чтобы взаимодействующие гравитоны обладали спином 2. Таким образом, на основе понятий полей с определенным спином распространенное стремление сделать все поля равноправными осуществляется путем сведения гравитационного поля в ранг обычных полей, а не путем геометризации всех полей в дополнение к гравитационному.

SPIN AND SYMMETRIES OF INTERACTIONS

V.I.Ogievetski and I.V.Polubarinov

The notion of the interacting field with definite spin is introduced on the basis of the inhomogeneous Lorentz group. All theories of vector fields with spin 1 are listed. In these theories:

1.The space-time property of vector fields to have spin 1 generates symmetries, which at first glance are not connected in any way with space time, e.g., symmetries, corresponding to the conservation of electric or baryon charge, isotopic or SU (3) invariance and so on.

2. Vector fields must be transformed according to the regular representation, so that e.g. the existence of 8 vector bosons is an argument in favour of the SU (3) invariance of strong interactions, and the ninth meson can be connected with the baryon number conservation.

3.Vector fields without baryon charge must have spin parity 1-(as it is in experiment).

4. The coupling constant is universal for interactions of the vector boson irreducible multiplet with other fields and with itself.

The present approach, in particular, reveals the meaning of Yang-Mills theories as theories of interacting vector fields with spin 1. There is no difficulty with mass of vector field, in fact, there are no limitations on mass.

Then we construct the theory of neutral tensor field $h_{\mu\nu}$ with spin 2 interacting with itself and with other fields. When mass of such a field is zero, then the equation of motion for it turn out to be Einstein equation for gravitation. It is of exceptional importance, that in this approach the space-time remains flat, and intrinsic to Einstein theory non-linearities are generated by the requirement that interacting gravitons must have spin 2 (and 0 but not 1).

Thus on the basis of the notion of fields with definite spin the widespread trend to treat all the fields on equal footings is realized by reducing gravitational field to the level of ordinary field, but not by means of geometrization of all the fields in addition to the gravitational one.

X-2

НАРУШЕННЫЕ СИММЕТРИИ ПРИ ОЧЕНЬ ВЫСОКИХ ЭНЕРГИЯХ

В.И.Огиевецкий

Объединенный институт ядерных исследований
Лаборатория теоретической физики, Дубна, СССР

Что происходит с нарушенными симметриями с ростом энергии? Часто встречается утверждение, что, когда энергия будет значительно превосходить массы всех частиц, участвующих в реакции, то разности масс частиц будут становиться несущественными и симметрии будут становиться все более и более точными. Так ли это?

В работе найдены асимптотические соотношения между амплитудами рассеяния октуплета на октуплете в октуплетной модели $SU(3)$ в предположении, что эффективный гамильтониантониан есть смесь унитарного синглета и три-три компоненты октуплета и что сечения рассеяния с перезарядкой пренебрежимо малы по сравнению с сечениями упругого рассеяния. Полученные соотношения суть аналоги массовой формулы Гелл-Манна-Неймана-Окубо и, например, соотношение для амплитуд упругого рассеяния барионов на нуклонах имеет вид

$$3A_{\Lambda N} + A_{\Sigma N} = 2(A_{NN} + A_{\Xi N})$$

Кратко обсуждается нарушение изотопической инвариантности электромагнитными взаимодействиями при высоких энергиях и эксперименты, в которых можно было бы проверить, восстанавливается ли эта инвариантность с ростом энергии.

BROKEN SYMMETRIES AT VERY HIGH ENERGIES

V.I.Ogievetskiĭ
Joint Institute for Nuclear Research
Laboratory of Theoretical Physics
Dubna, USSR

What happens with broken symmetries at very high energies? Often one can meet the assertion that when energy will considerably exceed masses of all particles participating in a reaction, then mass-differences will be be non-essential and symmetries will become more and more exact. Is that really the case?

We have found the asymptotic relations for amplitudes of octuplet-octuplet scattering in the eightfold way version of SU(3) under assumptions that the effective Hamiltonian is mixture of a unitary singlet and 3-3 component of octuplet. and exchange scatterings is negligible small in comparison with elastic ones. These relations are are analogs of the Gell-Mann-Neeman- Okubo mass formula and e.g., the relation for elastic scattering amplitudes of baryons on nucleons have the form

$$3A_{\Lambda N} + A_{\Sigma N} = 2\left(A_{NN} + A_{\Xi N}\right)$$

The brief discussion is given concerning the violation of isotopic invariance by electromagnetic interactions and experiments in which it is possible in principle to verify do this invariance will restore with energy increase or not.

X - 3

Origin of Unitary Symmetry and Charge Conservation in Strong Interactions

L. O'Raifeartaigh, Dublin Institute for Advanced Studies, Dublin, Ireland

T. S. Santhanam, Institute of Mathematical Sciences, Madras, India

and

E. C. G. Sudarshan, Brandeis University, Waltham, Massachusetts USA

To be presented by E. C. G. Sudarshan
Mailing address: Institute for Theoretical Physics, University of Bern, Sidlerstrasse 5, Bern, Switzerland.

We have investigated the interrelation of the existence of multiplets of (approximately) equal mass and equal spin particles and of their (strong) interactions. If we postulate a dynamical principle (the Smushkevich Principle) which asserts that the (renormalized) one-particle propagators of the various members of a multiplet are identical and that the baryon meson interactions are trilinear (Yukawa) interactions, we can deduce the unitary symmetry of the interactions. As a bye-product, we derive also the electric charge (and hypercharge) conservation in these interactions.

Concerning Space-Time and Symmetry Groups*

Meinhard E. Mayer, Howard J. Schnitzer, E.C.G. Sudarshan,
Brandeis University, Waltham, Massachusetts

R. Acharya, Northeastern University, Boston, Massachusetts U S A

and

M. Y. Han, Boston University, Boston, Massachusetts U S A

To be presented by

E.C.G. Sudarshan

Several theorems are proved which exhibit the impossibility of constructing non-trivial products of Lorentz group with internal symmetry groups for some physically interesting examples. It is also shown that if the Lorentz group is replaced by the Galilei group qualitatively different results are obtained; a "linear" breakdown of internal symmetry is possible.

*Supported in part by the National Science Foundation

REPRESENTATION MIXING FOR SU_3 AND G_2

A.J.Macfarlane and N.MUkunda
University of Rochester
E.C.G.Sudarshan
University of Bern

We study the breaking of SU_3-invariance in elementary perturbation theory, obtaining perturbed energies (masses) to second order and perturbed states to first order but normalized. Physical particles correspond not to states of pur representations of SU_3 but to states with small amounts of other representations mixed into the pure unperturbed states. Physical quantities are evaluated in terms of mixing parameters rather than of the coefficients of the Okubo "mass" formulae. We systematically examine the effect of simple choices of mixing parameters for the baryon and meson "octets" and baryon resonance "decuplet" on masses and magnetic moments. We may follow a similar approach to approximate G_2 invariance, and compare results with the SU_3 case. The electromagnetic Σ^0-Λ transition, allowed in lowest order by SU_3, remains forbidden up to first order in the G_2-violating interaction. Of the eight processes $Y_1^* \to \Lambda\cdot$, $\varphi \to \pi^0\gamma, \omega \to \pi^0\gamma$, $Y_0^* \to \Sigma\pi, \varphi \to K\bar{K}, \eta \to 3\pi^0$, $\eta \to \pi^0 + 2\gamma$, $\pi^0 \to 2\gamma$, all disallowed by exact G_2 invariance, the first three remain forbidden to first order, while the last five are allowed. Exact SU_3 invariance forbids only the decay $\varphi \to K\bar{K}$, for a singlet φ. The baryon magnetic moments obey the following non-trivial relations when first order violation of G_2 is taken into account

$$\mu(p)-\mu(\Sigma^+)=\mu(\Xi^-)-\mu(\Sigma^-) = 3\mu(n) - 3\mu(\Sigma^0);$$
$$\mu(n) = \mu(\Xi^0)$$

in contrast to the single relation obtained from SU_3 to this order:

$$\mu_T(\Sigma^0-\Lambda) = \frac{1}{2\sqrt{3}}\left[\mu(\Sigma^0) + 3\mu(\Lambda) - 2\mu(\Xi^0) - 2\mu(n)\right]$$

X - 6

ВЫРОЖДЕНИЕ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ ПО ИЗОСПИНУ И СУЩЕСТВОВАНИЕ π_0^0 - МЕЗОНА

А.М.Балдин и А.А.Комар

Физический институт им. П.Н.Лебедева АН СССР
Москва, СССР
Объединенный институт ядерных исследований
Дубна, СССР

Обсуждается возможное разделение сильных взаимодействий на два подкласса, один из которых обладает симметрией изотопических вращений, другой - более высокой симметрией. Рассматриваются некоторые проблемы теоретико-группового подхода и динамики, связанные с таким разделением. Подчеркивается наиболее интересное следствие обсуждаемой схемы - существование π_0^0 -мезона. π_0^0 - изоскалярный мезон с квантовыми числами 0^{-+} близкий по свойствам к обычному π -мезону, но взаимодействующий заметно слабее с нуклонами. Обсуждаются возможные эксперименты, в которых он мог бы быть обнаружен.

ISOSPIN DEGENERACY OF STRONG INTERACTIONS AND EXISTENCE OF π_o^o-MESON

A.M.Baldin and A.A.Komar

P.N.Lebedev Physical Institute Academy of Sciences of the USSR, Moscow
Joint Institute for Nuclear Research. Dubna

The possible division of strong interactions in two subclasses is discussed, one posessing the symmetry of isotopic rotations - the other with higher symmetry. Some problems of group theory approach and dynamics related to this division are analyzed.

The most striking consequence of the considered scheme - existence of π_o^o-meson is emphasized. π_o^o - is isos isoscalar meson with quantum numbers 0^{-+} very similar to the usual π-meson, but interacting with nucleon less strongly. The possible experiments in which it sould be detected are discussed.

SYMMETRY OF THE STRONG INTERACTIONS

Seitaro Nakamura

Department of Physics, University of Tokyo and Nihon University, Tokyo, Japan

HIDDEN SYMMETRIES IN FOUR-FERMION INTERACTIONS

R.E.Marshak and S.Okubo
The University of Rochester
Rochester, New York, USA

Let $\Psi_1, \ldots \Psi_n$ be n four-component spinors and suppose that they form a unitary multiplet in unitary n space. Then the Lagrangian (g is the coupling constant):

$$\mathcal{L} = \sum_{\lambda=1}^{n} \bar{\Psi}_\lambda \left(\gamma \frac{\partial}{\partial x}\right) \Psi_\lambda + g \sum_{\lambda=1}^{n} \sum_{\mu=1}^{n} (\bar{\Psi}_\lambda Q \Psi_\lambda)(\bar{\Psi}_\mu Q \Psi_\mu)$$

is invariant under U_n. If we decompose Ψ_λ into 2 two-component spinors, then we have shown previously[1] that $\mathcal{L}$ is invariant under higher ranking groups than the original U_n group. Depending on whether Q is scalar, vector, tensor, axial vector or pseudo-scalar, it turns out that $\mathcal{L}$ is, in turn, invariant under R_{2n}, $W_n = U_n \otimes U_n$, $US_p(2n)$, U_{2n} or R_{2n}. Since Heisenberg's theory is based on choosing one fundamental Dirac field (n = 1) and the axial vector interaction, the underlying group structure is U_2. It is now clear that the basic group is larger than U_2 and that n =3 is the next simplest choice (since n = 2 will not accomodate hypercharge in a natural way). With n = 3, the vector interaction leads to the group with the simplest structure (i.e. W_3) with the special feature that the parity operation couples the two U_3 groups comprising W_3. The resulting consequences will be discussed as will the properties of the other groups corresponding to n = 3.

---

1 Nuovo Cim. 19, 1226 (1961).

"Electromagnetic Mass Differences of Baryons and Mesons"

by

J. H. Wojtaszek, R. E. Marshak and Riazuddin
The University of Rochester
Rochester, New York U S A

Recent successes of the unitary symmetry model lead us to try to evaluate the four independent baryonic and two mesonic electromagnetic (E.M.) mass differences using this approach. We devise an approximation scheme and give arguments which relate our calculation to a dispersion theory treatment of the E.M. mass differences by W. N. Cottingham. Our calculation consists of evaluating five contributions to the mass differences: the elastic form factor parts, processes which involve the three isovector transitions π^0-η, Σ^0-Λ and ρ^0-ω, and what we call the self-induced mass differences. These last are the usual contributions in which mass differences of particles in bubble diagrams cause other mass differences. Unitary symmetry is used to supply values for quantities not given by experiment, e.g. form factors for strange particles and coupling constants. Our calculations yield the correct result for the pion mass difference calculated earlier[1] because the chief contribution is due to the elastic form factor part. The correct sign of the kaon mass difference can be obtained although the magnitude is uncertain. The observed baryonic mass differences can be approximately reproduced although the nearly equal Σ-hyperon mass splitting which is experimentally observed can not be fully explained because of the rather large isotensor form factor contribution .

---

[1] S. K. Bose and R. E. Marshak, Nuovo Cim. 25, 529 (1962).

SCALAR TADPOLES AND ELECTROMAGNETIC MASS SPLITTINGS

S. Coleman and R.Socolow
Harvard University, Cambridge, Mass., USA
S.L.Glashow
University of California, Berkeley, California; USA
H.J.Schnitzer
Brandeis University, Waltham, Mass., USA

We describe a method (based on unitary symmetry) for the calculation of electromagnetic mass splittings within isotopic multiplets. We take account of the effects of scalar meson tadpoles and of the leading nontadpole contributions. The calculation involves experimental quantities and one free parameter. We are able to obtain good agreement with the experiment for the four baryon splittings, the pion splittings, and the recently measured Y_1^* splitting. For the kaon splitting we obtain the right sign, but only half the proper magnitude. We also discuss the decay $\omega \to 2\pi$.

MASS FORMULA IN BROKEN SYMMETRY

Yasunori Fujii, Munetake Ichimura
and
Koichi Yazaki
Institute of Physics
College of General Education
University of Tokyo
Tokyo, Japan

Validity of a linear mass formula in a broken symmetry scheme is investigated using a Lee type model. Questions raised by Oakes and Yang are discussed. It is concluded that a linear mass formula can be valid under certain conditions while there are some cases where no mass formula is expected. It is also discussed that a perturbative mass formula may apply better to the poles of K-matrices (K-masses) than to the actual masses. The consistency of an assumed linear K-mass formula is examined in the case of the decuplet P resonances in SU_3.

MASS SPECTRUM OF PARTICLES

Seitaro Nakamura

Department of Physics, University of Tokyo and Nihon University, Tokyo, Japan

X-I3

УНИТАРНАЯ СИММЕТРИЯ И ПОЛЮСА РЕДЖЕ

Малюта Ю.М.

Институт физики АН Украинской ССР,
Киев, СССР

Предложена унитарно симметричная модель составных частиц. В качестве фундаментальных частиц в этой модели фигурируют нуклон, Λ -гиперон, каон и η -мезон.

Для вычисления масс составных частиц применяется метод полюсов Редже.

Асимптотика типа Редже находится путем суммирования диаграмм Куткоского.

Вычисленные массы барионов и векторных мезонов близки к наблюдаемым массам.

X - 13

UNITARY SYMMETRY AND REGGE POLES

Yu.M.Malyuta

Institute of Physics of the Ukrainan Academy
of Sciences
Kiev, USSR

X-I3

УНИТАРНАЯ СИММЕТРИЯ И ПОЛЮСА РЕДЖЕ

Малюта Ю.М.

Институт физики АН Украинской ССР,
Киев, СССР

Предложена унитарно симметричная модель составных частиц. В качестве фундаментальных частиц в этой модели фигурируют нуклон, Λ -гиперон, каон и η -мезон.

Для вычисления масс составных частиц применяется метод полюсов Редже.

Асимптотика типа Редже находится путем суммирования диаграмм Куткоского.

Вычисленные массы барионов и векторных мезонов близки к наблюдаемым массам.

X-I4

АНОМАЛЬНЫЕ ПОРОГИ И СПЕКТР МАСС ЭЛЕМЕНТАРНЫХ ЧАСТИЦ

Э.В.Гедалин, О.В.Канчели, Л.В.Лаперашвили,
С.Г.Матинян

Институт физики АН ГССР, Тбилиси, СССР

Взаимопревращения известных элементарных частиц, стабильных по отношению к сильным взаимодействиям, характеризуются соотношениями аномальности. Иначе говоря, для любой тройки неодинаковых взаимопревращающихся частиц из схемы Гелл-Манна-Нишижимы мы имеем соотношения

$$M_1 < M_2 + M_3$$
$$M_1^2 > M_2^2 + M_3^2 \qquad (I)$$

Эта закономерность не имеет ни одного исключения. Можно рассматривать аномальные соотношения (I) между массами частиц как соотношения, регулирующие спектр масс стабильных по отношению к сильным взаимодействиям элементарных частиц. В самом деле, в принципе можно было бы представить себе ситуацию, в которой масса π и K -мезонов несколько больше существующих, так что вершины $\Sigma \to \Lambda\pi$, $\Lambda \to \bar{K}N$, $\Sigma \to \bar{K}N$, $\Xi \to \Lambda\bar{K}$, $\Xi \to \Sigma\bar{K}$ стали бы нормальными, а выводы схемы Гелл-Манна в отношении сильных взаимодействий остались бы прежними.

Применение "принципа аномальности" к частицам, которые имеют место в схеме Гелл-Манна, но еще не открыты с достаточной убедительностью (Ω - мезон со странностью $S = 2$, Ω - гиперон с $S = -3$), приводит к интервалам для масс этих частиц, в которые попадают значения масс, данные экспериментаторами, наблюдавшими эти частицы (масса в Бэв):

$$0{,}69 < M_\Omega < 0{,}93$$
$$1{,}4 < M_\Omega < 1{,}82$$

ANOMALOUS THRESHOLDS AND THE MASS SPECTRUM OF ELEMENTARY PARTICLES

E.V.Gedalin, O.V.Kancheli, L.V.Laperashvili, S.G.Matinyan

Institute of Physics of the Academy of Sciences of the Georgian SSR

Interconversion of known elementary particles stable with respect to strong interactions are characterized by anomalous relations. In other words for any three different interconvertible particles we have the following relations from the scheme of Gell-Mann-Nishizhima.

$$M_1 < M_2 + M_3 , \quad M_1^2 > M_2^2 + M_3^2 \qquad (1)$$

This regularity has no exception. One can consider the anomalous relations (1) between particle masses as relations regulating the spectrum of mass stable with respect to strong interactions of elementary particles. Indeed, in principle one could have imagined the situation in which the masses of π and K-mesons are rather bigger than the existing ones, so that the vertices $\Sigma \to \Lambda\pi$, $\Lambda \to \bar{K}N$, $\Sigma \to \bar{K}N$, $\Xi \to \Lambda\bar{K}$, $\Xi \to \Sigma\bar{K}$ would become normal and the conclusions of the scheme of Gell-Mann - with respect to strong interactions would remain the same.

The use of the "principle of anomaly" for the particles which take place in Gell-Mann scheme, but are not yet discovered with sufficuent validity (D-meson with the strangeness $S = 2$, Ω -hyperon with $S = -3$), leads to the intervals for the masses of these particles, in which the values of masses, given by experiments, who observed them are included (mass is in BeV):

$$0.69 < M_D < 0.93$$
$$1.4 < M_\Omega < 1.82$$

SPECULATIONS ON THE ORIGIN OF $J^P = \frac{3}{2}^+$ RESONANCES

R. F. Sawyer

Department of Physics, University of Wisconsin
Madison, Wisconsin, USA

The question is raised of how a possible $\frac{3}{2}^+$ octet in the 1600 MeV region (including $N^*(1512)$ and $Y_1^*(1660)$) could fit into the unitary symmetry scheme. Arguments on the basis of partial widths seem to rule out the single baryon exchange mechanism in SU_3 for producing both the decuplet and the conjectured octet. Various schemes are considered for consolidating the decuplet and octet into a single representation of $W_3 = U_3 \otimes U_3$. The scheme based on the 45 dimensional representation (8 + 10 + 27 with 27 at a higher mass) is also not favored by experimental partial widths. A scheme is presented which is based on the 18 dimensional representation, in which the $\frac{3}{2}^+$ resonances are considered as bound states of vector mesons and nucleons. In this scheme the actual isobar decays (except for $Y_1^*(1660) \rightarrow Y_1^*(1385) + \pi$ and $N^*(1512) \rightarrow N^*(1238) + \pi$) are allowed only through the strong breaking of W_3 symmetry.

Breaking of SU(3) Symmetry in the $3/2^+$ Meson-Baryon Decuplet

K. C. Wali*

Argonne National Laboratory, Argonne, Illinois USA

Robert L. Warnock

Illinois Institute of Technology, Chicago, Illinois USA

Breaking of SU(3) invariance is studied in the case of the meson-baryon decuplet with $J^P = 3/2^+$. In a simple theory based on single-baryon exchange, the evolution of the broken decuplet from a degenerate origin is traced in detail. Symmetry breaking is introduced by allowing initially degenerate meson and baryon masses to approach continuously their physical values, while obeying at every stage the Gell-Mann-Okubo sum rules. The following conclusions are reached. (i) The Okubo equal spacing rule for the decuplet levels follows from the validity of the Gell-Mann-Okubo rules for the meson and baryon octuplets. (ii) The main effect of the symmetry breaking may be characterized as a mixing of the 10- and 27-dimensional representations. The mixing is small enough so that the resonances can be unambiguously associated with the 10 representation, but at the same time large enough to imply coupling constant ratios differing appreciably from the values for pure symmetry. (iii) In the approach to pure symmetry through reduction of mass differences, there are no difficulties of the type pointed out by Oakes and Yang. Resonances cross thresholds smoothly, and a degenerate decuplet of bound states is obtained in the limit.

*Work performed under the auspices of the U.S. Atomic Energy Commission.

RELATION AMONG DECAY AMPLITUDES OF DECUPLET PARTICLES IN BROKEN UNITARY SYMMETRY

C.Becchi, E.Eberle and G.Morpurgo

Istituto di Fisica dell'Università and Sezione INFN-
Genova, Italy

It is shown that a relation exists among the following decay amplitudes: $N^* \to \Lambda + \pi$, $Y_1^* \to \Sigma + \pi$, $Y_1^* \to \Lambda + \pi$, $\Xi^* \to \Xi + \pi$ if unitary symmetry is broken by a term of the kind T_3. The relation is compared with the experimental data.

Comparison of SU_3 Predictions with Reaction Cross Sections

S. Meshkov*

National Bureau of Standards, Washington D. C., U.S.A.

G. A. Snow and G. B. Yodh†

University of Maryland, College Park, Maryland, U.S.A.

SU_3 yields the prediction that the following amplitudes for reactions of the type: meson + baryon → baryon resonance + meson should be equal, when there is no symmetry breaking in the interaction[1].

$$(\pi^- p | N^{*-} \pi^+)/\sqrt{3} = (K^- p | Y_1^{*-} \pi^+) = (\pi^- p | Y_1^{*-} K^+) = (K^- p | \Xi^{*-} K^+)$$

A comparison of the experimental cross sections for these processes at various energies is made in a manner similar to that used successfully in an earlier analysis of $\pi^+ p$ and $K^+ p$ initiated processes[2]. It is found that for $Q < 600$ MeV ($Q = E^* - M_3 - M_4$), the SU_3 equality predictions are badly violated in an interesting way. They split into two groups. The amplitudes for the first two processes are large and similar, passing through a maximum at $Q \simeq 300$ MeV, whereas the latter two processes are small and equal. At $Q \geq 600$ MeV all four processes tend to be equal within large errors. Possible reasons for this apparent breakdown of SU_3 will be discussed and the results correlated with those of the earlier $\pi^+ p$ and $K^+ p$ analysis.

*Work supported in part by the U. S. Office of Naval Research

†Work supported in part by U.S. Atomic Energy Commission

(1) S. Meshkov, C. A. Levinson and H. J. Lipkin, Phys. Rev. Letters 10, 361(1963)

(2) S. Meshkov, G. A. Snow and G. B. Yodh, Phys. Rev. Letters 12, 87(1964)

О СВОЙСТВАХ B -РЕЗОНАНСА

В.М.Шехтер

Ленинградский Физико-технический
Институт, Ленинград, СССР

Поскольку B -резонанс найден в системе $\pi^{\pm}\omega$ и отсутствует для $\pi^{\pm}\pi^{0}$, его квантовые числа могут быть равны 0^{-}, 1^{+}, 2^{+}, 2^{-}, 3^{+} и т.д. Наиболее вероятны, по-видимому, 0^{-} и 1^{+}. В первом случае ω -мезон от распада $B \to \omega + \pi$ рождается полностью выстроенным с нулевой проекции спина на направление своего движения. Поэтому при распаде $\omega \to \pi^{+}\pi^{-}\pi^{0}$ распределение по углу θ между нормалью к плоскости распада и направлением движения ω в системе покоя ω должно иметь вид $\sim \cos^{2}\theta$. Для других значений спина выстроенность, вообще говоря, является частичной, а распределение по θ пропорционально $A + B\cos^{2}\theta$ с $A \neq 0$.

Если B -резонанс входит в унитарный октет, вторым членом которого является резонанс в системе $\pi^{\pm}K^{\pm}K^{0}_{1}$ с $m \simeq 1410$ Мэв, то третий член этого октета должен распадаться на $K + 2\pi$ или $K^{*} + \pi$ и иметь массу ~ 1365 Мэв.

ON THE PROPERTIES OF B RESONANCE

V.M.Shekhter

Physical-Technical Institute, Leningrad, USSR

Since B resonance is found in the $\pi^{\pm}\omega$ system and it is absent for the $\pi^{\pm}\pi^{0}$ system, its, quantum numbers may be 0^-, 1^+, 2^+, 2^-, 3^+, etc. One may think the quantum numbers 0^- or 1^+ are the most probable. For the quantum numbers 0^- the ω-meson from the decay $B \to \omega + \pi$ is produced being totally alligned with zero spin projection in the direction of its motion. In the decay of such a state into $\pi^+\pi^-\pi^0$ the angular distribution between the decay plane normal and the ω momentum in the ω rest system must be of the form $\sim \cos^{-2}\theta$. For other B resonance quantum numbers the allignment is, generally speaking, only partial and the angular distribution is proportional to $A + B\cos^2\theta$ with $A \neq 0$.

If B resonance is a number of a unitary octet with the second member being the resonance at 1410 MeV in the $K^0_I K^{\pm}\pi^{\mp}$ system, the third member of the octet must be a resonance with the mass $\sim$ 1365 MeV in the system $K + 2\pi$ or $K^* + \pi$.

BROKEN SU (3) ⊗ SU(3) ⊗ SU(3) ⊗ SU(3) SYMMETRY

Y.Nambu and P.G.O.Freund
University of Chicago, Chicago, USA

We propose that there may exist a hierarchy of higher symmetries than SU(3) which go up to SU(3) ⊗ (SU(3) ⊗ SU(3) ⊗ SU(3). They are obtained by taking left-handed and right-handed components of 9(= octet + singlet) baryons separately. Thus the large algebra consists of 4 sets of 8 generators F^V, F^A, D^V, D^A, where V = vector, A = axial vector, F=antisymmetric-type, D-symmetric-type. Several subalgebras can be constructed and we examine their predictions. The main consequences are

1) D^A or possibly $F^A + D^A$ seems to be favored by nature for weak axial vector currents and pseudoscalar octet coupling.

2) D^V introduces two new quantum numbers I_3', Y' which can be assigned to 9 baryons, and lead to new selection rules such as $N + \Xi \not\to \Sigma + \Sigma$. This symmetry should be badly broken, resulting in the splitting of octet and single (1405 MeV Y_0^*) baryons. The spin-parity of Y_0^* can be either $\frac{1}{2}^+$ or $\frac{1}{2}^-$.

BROKEN U(4)-SYMMETRY IN BARYON-MESON SYSTEM

Mitsuru Hama, Ken-iti Matumoto[X] and Sho Tanaka[XX]

Department of Applied Mathematics, Faculty of Engineering Science, Osaka University, Toyonaka, Japan

[X] Research Institute for Fundamental Physics, Kyoto University, Japan

[XX] Department of Physics, Kyoto University, Kyoto, Japan

Recently, in order to clarify the physical basis of SU(3)-Symmetry, several attempts has been proposed. Instead of the Sakata triplet (p, n and Λ), they worked with the quartet χ (χ_1, χ_2, χ_3 and χ_4) of spin $\frac{1}{2}$, of which χ_4 belong to U(1) whereas the other to U(3).

According to their models, strong interactions are subjected to a "broken U(1) x U(3)"- symmetry or a "broken U(4)" - symmetry,

In this note, we propose a "broken U(4)" - symmetry in baryon-meson system and the related mass formula and investigate its characteristic consequences.

QUARTET SCHEME FOR ELEMENTARY PARTICLES[x]

Ziro Maki and Yoshio Ohnuki
Institute for Theoretical Physics, Nagoya University, Nagoya, Japan

A possible unified model for elementary particles is developed by generalizing the view point of Sakata-Nagoya model. Instead of the Sakata triplet (p, n, and Λ), we work with the quartet of new baryons χ_0 and χ (χ_1, χ_2 and χ_3) of spin $\frac{1}{2}$, of which χ_0 belongs to U(1) whereas the other three to U(3).

Strong interactions are subjected to a "broken U(1) x U(3)" symmetry. Baryon octet (N, Σ, Λ and Ξ) and meson octets (K, π η $\bar{K}$; etc.) are interpreted, respectively, as the three ($\chi \bar{\chi} \chi_0$) - or two ($\chi\bar{\chi}$) -body composite systems both belonging to 8-dimensional representations of SU(3). One of the crucial test of the model is the prediction of triplet mesons ($\chi \bar{\chi}_0$), the iso-doublet of which can be identified with K -mesons. The baryon quartet, χ_0 and χ, correspond to four leptons in the sense of "Modified" baryon-lepton symmetry. This enables us to explain Cabibbo's phenomenological weak interaction as a consequence of the present scheme.

---

[x]Progress of Theoretical Physics, in press.

POSSIBILITY OF STRONG INTERACTION BETWEEN PLURAL INTERMEDIATE VECTOR MESONS

Kanji Fujii and Kenzo Iwata
Department of Physics, Hokkaido Univ., Sapporo, Japan

Intermediate vector mesons were introduced as the origin of various aspects of weak interactions. The mass of this meson is estimated to be heavy (> nucleon mass) from various experimental considerations. This fact seems for us to be peculiar. Because, we have some conviction about the connection between the mass of particle and its behaviour of interaction, that is, particles heavier than nucleon (we take a standpoint that mesons such as π and K are composed of fundamental baryons as Sakata says) possess always both strong and weak interaction.

It seems to us as follows: — "There are some kind of matter (Nagoya group says this as B-matter) which makes leptons as heavy as baryons and at the same time gives them ability of strong interaction", and further, "This matter some times does appear as intermediate vector meson (as ε - charge does). That is to say, we expect intermediate vector meson is not only the origin of weak interaction but also the carrier of strong interaction under certain circumstances.

The isolated intermediate meson behaves merely as the origin of weak interaction, but between the plural intermediate vector mesons there appears strong interaction. (This opinion is analogous to Pais's Even-Odd rule). We suspect B-matter or intermediate vector meson belongs to the category beyond the quantum theory, but analysis is carried out in the words of the present theory taking care of the limit of application.

We assume for simplicity the following strong interaction between plural intermediate vector mesons and estimate some probable effects;

$$H_{int} = \lambda_N (B^+_\mu B_\mu)(\bar{N}N) + \lambda_\Lambda (B^+_\mu B_\mu)(\bar{\Lambda}\Lambda) + \lambda (B^+_\mu B_\mu)^2$$

(Coupling constants λ_N, λ_Λ and λ are assumed to be ~ 1 in the units of $\hbar = 1$, $c = 1$, r_0 ($\simeq 10^{-13}$ cm) = 1 and $m_B >$ nucleon mass).

Results are as follows: 1)Such interactions lead to parity conservation in strong interactions under the assumption of T-invariance. ii) In high energy N-N collisions, production-cross-section of even number of B-mesons are very large, and subsequent decays of those B-mesons give rise to copious production of leptons, which is a marvelous character of this model. This seems to have some connection, with μ-rich air shower. iii) The production cross section of B-meson in lepton-nucleon collision is larger ($\sim 10^4$) than that expected ordinary theories. Probability of six-body Fermi processes (such as $p^+ + p^+ \to p^+ + n + e^+ + e^+ + \nu + \bar{\nu}$) is too small to observe. iv)The weak vector current $j^{(V)}_\mu = \frac{i}{2}\bar{p}\gamma_\mu n$ is divergenceless. For appropriate value of λ_N and λ_Λ , one may expect to have qualitative features of the relation among weak coupling constants. As virtual effects due to B-meson strong interaction, the self energy problem is also considered.

FUNDAMENTAL QUANTUM NUMBERS IMBEDDED IN RELATIVISTIC WAVE EQUATIONS

Alladi Ramakrishnan

Institute of Mathematical Sciences
Madras, India

The basic problem of imbedding fundamental quantum numbers into relativistic wave equations of elementary particles is discussed. A comparison is made of the meaning of antiparticles in the case of bosons and fermions and its possible connection with mass reversal transformation is pointed out. This leads to the necessity of postulating a fundamental baryon with $I = 0$ and $Y = 0$. Its relation to the symmetries and group structure of particles and resonances is indicated.

РАСПАДЫ ДВОЙНОГО ГИПЕРЯДРА $_{\Lambda\Lambda}He^{6}$.

В.А.Филимонов

НИИ Ядерной физики, электроники и автоматики,
Томск, СССР

В гиперядре $_{\Lambda\Lambda}He^{6}$ барионы образуют три замкнутые оболочки: протонную, нейтронную и Λ - частичную. Можно ожидать, что это гиперядро будет обладать особой устойчивостью и наиболее обильно образовываться при захвате Ξ^- ядрами. Рассчитываются вероятности распада гиперядра $_{\Lambda\Lambda}He^{6}$ по различным каналам в предположении, что гиперядро представляет систему трех тел: α - частицы и двух Λ - частиц. Рассмотрены лишь распады, при которых α - частица не разрушается: π -мезонные

$$_{\Lambda\Lambda}He^{6} \begin{cases} \to He^{4} + \Lambda + p + \pi^- \\ \to He^{4} + \Lambda + n + \pi^0 \\ \to {}_{\Lambda}He^{5} + N + \pi \end{cases}$$

немезонные, Σ - гиперонные распады

$$_{\Lambda\Lambda}He^{6} \to \begin{matrix} He^{4} + \Sigma^- + p \\ He^{4} + \Sigma^0 + n \end{matrix}$$

а также немезонные распады через резонансные состояния типа

$$_{\Lambda\Lambda}He^{6} \to {}_{\Sigma^-}H^{5*} + p$$

Найдено, что Σ -гиперонные распады могут составлять несколько процентов от мезонных распадов.

X - 25

DECAYS OF DOUBLE HYPERFRAGMENT $_{\Lambda\Lambda}He^{6}$

V.A.Filymonov

Scientific Research Institute of Nuclear Physics,
Electronics and Automation, Tomsk, USSR

Trilinear Couplings Forbidden by Nonet Symmetry for Vector Mesons.

J.J. Sakurai (University of Chicago).

We demonstrate that any higher symmetry that makes the approximate degeneracy of vector meson singlet and the vector meson octet non accidental and gives the vector meson mass formulae of Okubo and others forbids a number of trilinear couplings which are known to exist with appreciable strength. First, the very existence of the couplings :

$$\rho \longleftrightarrow \pi\pi \quad , \; K^{*} \longleftrightarrow K\pi, \text{ etc.}$$

necessarily breaks nonet symmetry. Similarly the couplings :

$$N^{*}_{3/2} \longleftrightarrow N\rho \quad , \quad Y^{*}_{1} \longleftrightarrow N\bar{K}^{*}$$

(which play important roles in the vector meson exchange model for isobar production) are forbidden by nonet symmetry unless there exists an additional $J = \frac{3}{2}^{+}$ multiplet belonging to the representation 8 as in Schwinger's W_3 model. Meanwhile Schwinger's model is in difficulty because it forbids the $K^{*}\Sigma\bar{N}$ and $K\Sigma\bar{N}$ couplings which are known to be important in reactions :

$$p + \bar{p} \rightarrow \Sigma^{+} + \bar{\Sigma}^{+}, \; \Lambda + \bar{\Sigma}^{0} \; , \; \Sigma^{0} + \bar{\Lambda} \quad .$$

SYMPLECTIC SYMMETRY OF HADRONS

H. Bacry, J. Nuyts and L. Van Hove

CERN--Geneva

A model is proposed for SU_3 symmetry in which the known SU_3 multiplets of hadrons (strongly interacting particles) are considered as bound states of basic particles t of spin $\frac{1}{2}$, baryon number 1 and electric charge $0,\pm1$, and of their antiparticles $\bar{t}$. These basic particles form SU_3 triplets and are regarded to be heavy compared to the proton mass. The known meson octets and singlet are supposed to result from binding of a t and a $\bar{t}$, giving in terms of SU_3 symmetry the structure $\bar{3}\times3 = 1+8$. The baryon octet, decuplet (and possibly singlet) are given the composition $\bar{t}tt$, with the SU_3 structure $3\times3\times3 = 1+8+8+10$. These requirements, and the condition to minimize the number of basic particles, lead uniquely to the introduction of 6 basic particles t, one 3 triplet of charges $+,0,0$ and one $\bar{3}$ triplet of charges $0,+,+$. They are associated with the values $\frac{1}{3}$ and $-\frac{1}{3}$ of a new quantum number Z. For the known particles Z is equal to the baryon number.

One then introduces a higher symmetry group incorporating the new quantum number as well as SU_3. This is done within the framework of simple Lie groups, and we are led to select the symplectic group in six dimensions Sp_6, whose lowest dimensional representation exactly accommodates the six basic particles t. With this higher symmetry the model predicts a SU_3 triplet of new pseudoscalar mesons, a SU_3 sextet of new vector mesons, as well as their antiparticles, with mass separations calculable from the masses of the known mesons. For the known pseudoscalar mesons and baryons one finds the usual Gell-Mann Okubo mass formulae, whereas for the known vector mesons one derives a mass relation identical to the formula obtained in Schwinger's W_3 symmetry model. Our model predicts in addition many new baryon resonances of high mass and large width. All mass predictions are obtained by taking a mass splitting operator of form $\Delta m_1 + \Delta m_2$, where Δm_1 breaks Sp_6 symmetry but preserves SU_3, while Δm_2 breaks SU_3. Δm_1 is regarded as larger than Δm_2 and is taken to second order, while for Δm_1 only first order effects are included. We are led to this assumption of a symmetry violation which is larger for Sp_6 than for SU_3 by the circumstance that the first order mass splitting effects leave the new mesons to be degenerate in mass with the known ones, a situation which is unattractive in several respects.

X-28

Spin-Parity Determinations for Elementary Particles and Resonances

Charles Zemach

University of California, Berkeley, California, U.S.A.

We wish to (a) advertise the virtues of tensor representations for angular momentum states in elementary particle phenomena and (b) exploit there virtues in attempting to uncover systematically all tests for measuring spins and parities. Within the tensor formation, the intuition which physicists commonly apply to vectors is appliceble to systems of arbitrary angular momentum, whether or not the spin-bearing particles are at rest. Composition of angular momenta, construction of irreducible tensor operators, partial wave projections, etc., may be carried out without tables of Clebsch-Gordan coefficients or spherical top functions. A natural framework is provided for study of angular correlations and maximum complexity theorems for intensities, polarization vectors, and higher polarization multipoles. Reactions involving the newly found mesons which decay into $\pi + \omega$ and $\pi + \rho$, and some theorems on "magic directions" will be discussed as illustrations.

ЭНЕРГЕТИЧЕСКАЯ ЗАВИСИМОСТЬ ВРЕМЕНИ ЖИЗНИ КВАЗИСТАЦИОНАРНЫХ СОСТОЯНИЙ

А.И.Базь

Институт атомной энергии им. В.И. Курчатова,
Москва, СССР

Получена формула, определяющая зависимость времени жизни квазистационарного состояния от точного значения энергии.

Задача ставится следующим образом. Пусть в рассеянии частицы на какой-то системе имеется резонанс с шириной Г, расположенной при энергии E_0. Требуется найти время жизни квазистационарного состояния Т как функцию энергии рассеиваемой частицы Е.К. этой задаче имеется несколько подходов.

I. Один основан на работе Вигнера (I). Рассмотрим волновой пакет, рассеиваемый на потенциале радиуса R. При $r > R$ имеем

$$\chi_{\kappa}(r) + \chi_{\kappa+d\kappa}(r) = \left(e^{-ikr - \frac{iEt}{\hbar}} + e^{-i(\kappa+d\kappa)r - \frac{i(E+dE)}{\hbar}t}\right) -$$

$$- \left(e^{ikr - \frac{iEt}{\hbar} + 2i\delta(\kappa)} + e^{i(\kappa+d\kappa)r - \frac{i(E+dE)t}{\hbar} + 2i\delta(\kappa+d\kappa)}\right)$$

где δ – фаза рассеяния. Центр тяжести падающего пакета определяется условием равенства фаз двух членов в падающей

ENERGY DEPENDENCE OF THE LIFE-TIME OF QUASISTATIONARY STATES

A.I.Baz

I.V.Kurchatov Atomic Energy Institute, Moscow,USSR

X-30

НЕКОТОРЫЕ ВОПРОСЫ ТЕОРИИ КВАЗИСТАЦИОНАРНЫХ СОСТОЯНИЙ

А.И.Базь

Институт атомной энергии им. Курчатова И.В.

Рассматриваются вопросы:

а) о времени жизни и законе распада квазистационарных состояний, заселенных не по лоренцеву закону $(W \neq [(E-E_0)^2+\Gamma^2]^{-1})$

б) о том, какие поправки возникают при описании процессов рассеяния и реакций, из-за нестабильности участвующих в процессе частиц.

SOME QUESTIONS OF THE QUASISTATIONARY STATES THEORY

A.I.Baz

We consider problems:

a) On the time dependent wave function of the quasi-stationary states populated not by the Lorentz low ($W \neq [(E-E_0)^2 + \Gamma^2]^{-1}$)

b)On the corrections to the theory of the scattering and reactions processes due to the instability of the participating particles.

COMPLETE SETS OF SPIN TESTS

M.Ademollo, R.Gatto, G.Preparata

Istituto di Fisica dell'Università di Firenze
Laboratori Nazionali del C.N.E.N. Frascati (Roma)

The necessary and sufficient conditions - in the absence of dynamical information - for a given spin assignment to a boson or fermion produced from a spin-0 boson on an unpolarized spin-½ fermion are determined. The derivation is based on a general theorem that imposes an upper limit to the ranks of two matrices into which the density matrix can be uniquely split, by using invariance under reflection through the production plane (R-operation). Production of a higher spin fermion decyaing into a spin-½ fermion and a spin-0 boson, and of a boson decaying into two spin-0 bosons or three spin-0 bosons or into a spin-1 boson and a spin-0 boson, or into two light spin-½ fermions are discussed in detail.

X-32

ОБОБЩЕННЫЕ ПРЕОБРАЗОВАНИЯ ЛОРЕНЦА И ИХ ГЕОМЕТРИЧЕСКАЯ СТРУКТУРА

О.С. Иваницкая, А.Е.Левашев

Институт физики АН БССР

Эти преобразования используются в общековариантных теориях волновых уравнений. Доклад посвящается изучению геометрической структуры обобщенных (локальных) преобразований Лоренца. Сначала эта структура рассматривается для случая специальной теории относительности, затем - римановых и неримановых пространств. Дискутируется соотношение между калибровочными преобразованиями и "смещениями, ассоциированными с циклом" (по Е.Картану). Показывается, что преобразования Галилея характеризуются более сложной геометрической структурой. Используются тензорный и спинорный формализмы.

GENERALIZED LORENTZ TRANSFORMATION AND ITS GEOMETRICAL STRUCTURE

O.S.Ivanitskaya, A.E.Levashev

Institute of Physics of the Belorussian Academy of Sciences

This transformation use is made in generally covariant theories of wave equations. The report is devoted to the study of the geometrical structure of generalized (local) Lorentz transformation. For one thing this structure is considered in the case of the special relativity, for another - R_i- emannian and nonriemannian spaces. The relation between the gauge conditions and "the displacements associated with cycle" (by E.Cartan) is discussed. It is shown that generalized Galilei transformation is characterized by a rather more intricate geometrical structure. The tensor and spinor formalism are used.

OCTET ENHANCEMENT

Roger F. Dashen, Steven C. Frautschi, Murray Gell-Mann, and Yasuo Hara

California Institute of Technology, Pasadena, California

SYMPLECTIC SYMMETRY OF HADRONS

H. Bacry, J. Nuyts and L. Van Hove

CERN - Geneva

III

ОБЩИЕ ПРИНЦИПЫ ЛОКАЛЬНОЙ ТЕОРИИ И ЭКСПЕРИМЕНТАЛЬНЫЕ СЛЕДСТВИЯ

Теория

GENERAL PRINCIPLES OF LOCAL FIELD THEORY AND THEIR EXPERIMENTAL CONSEQUENCES

Ш- I

АСИМПТОТИЧЕСКИЕ СООТНОШЕНИЯ МЕЖДУ АМПЛИТУДАМИ РАССЕЯНИЯ В ЛОКАЛЬНОЙ ТЕОРИИ ПОЛЯ

А.А. Логунов, Нгуен Ван-хьеу, Тодоров И.Т.,
О.А.Хрусталев

Объединенный институт ядерных исследований
Лаборатория теоретической физики
Дубна

На основе общих принципов релятивистской теории поля получен ряд асимптотических соотношений между амплитудами (и сечениями) различных процессов рассеяния и формфакторов при больших энергиях. Все выводы основаны на предположении, что амплитуды не осциллируют при высоких энергиях и на теореме Фрагмена и Линделёфа в теории аналитических функций.

ASYMPTOTIC RELATIONS BETWEEN SCATTERING AMPLITUDES IN LOCAL FIELD THEORY

Logunov A.A., Nguyen van Hieu, Todorov I.T.,
Khrustalev O.A.

Joint Institute for Nuclear Research
Laboratory of Theoretical Physics
Dubna

A number of asymptotic relations between the amplitudes (and cross sections) of different scattering processes at high energy has been obtained on the basis of general postulates of the local relativistic quantum field theory. All the conclusions are drawn according to Phragmen-Lindelof's theorem in the theory of analytical functions and under the assumption that at high energies the amplitudes should not oscillate.

Ш-2

ОБ АСИМПТОТИЧЕСКИХ СООТНОШЕНИЯХ МЕЖДУ ПОЛЯРИЗАЦИЯМИ В ПЕРЕКРЕСТНЫХ РЕАКЦИЯХ

С.М.Биленький, Нгуен Ван-хьеу, Р.М.Рындин

Объединенный институт ядерных исследований
Лаборатория теоретической физики
Дубна

Получены асимптотические соотношения между поляризациями в перекрестных реакциях. В частности, показано, что при больших энергиях поляризации в процессах упругого рассеяния нуклонов и антинуклонов нуклонами одинаковы по величине и противоположны по знаку. Рассмотрены также поляризации в процессах рассеяния мезонов нуклонами и в реакциях с участием странных частиц и γ - квантов.

ON ASYMPTOTIC RELATIONS BETWEEN THE POLARIZATIONS IN CROSSED CHANNELS

S.M.Bilenky, Nguyen van Hieu, R.M.Ryndin

Joint Institute for Nuclear Physics
Laboratory of Theoretical Physics
Dubna

Asymptotic relations between polarizations in crossed channels have been obtained. In particular, it has been shown that polarizations in elastic scattering of nucleons and antinucleons on nucleons are equal in magnitude and opposite in sign at high energies.

Polarizations in the scattering of mesons on nucleons and in reactions involving strange particles and γ - quanta have also been examined.

Ш -3

ВЫСШИЕ СИММЕТРИИ СИЛЬНЫХ ВЗАИМОДЕЙСТВИЙ И АСИМПТОТИЧЕСКИЕ СООТНОШЕНИЯ МЕЖДУ СЕЧЕНИЯМИ МЕЗОН-БАРИОННОГО РАССЕЯНИЯ

А.А.Логунов, Нгуен Ван-хьеу, Сян Дин-чан

Объединенный институт ядерных исследований

Лаборатория теоретической физики

Дубна

Рассмотрены некоторые возможности экспериментальной проверки моделей сильных взаимодействий с высшими симметриями: октетной модели, модели Сакаты и модели G_2 .

III-3

HIGHER SYMMETRIES OF STRONG INTERACTION AND ASYMPTOTIC RELATIONS BETWEEN MESON-BARYON SCATTERING CROSS SECTIONS

A.A. Logunov, Nguyen van Hieu, Hsien Ting chang

Joint Institute for Nuclear Research
Laboratory of Theoretical Physics
Dubna

Some posibilities are considered for the experimental test of the strong interaction models with higher symmetries: Octet model, Sakata model and G_2 model.

ОБ АСИМПТОТИЧЕСКОМ РАВЕНСТВЕ ПОЛНЫХ И ДИФФЕРЕНЦИАЛЬНЫХ СЕЧЕНИЙ ЧАСТИЦЫ И АНТИЧАСТИЦЫ

Н.Н. Мейман.

Институт теоретической и экспериментальной физики
Москва, СССР.

I. Дается строгий вывод асимптотического равенства полных сечений частицы и античастицы в широком диапазоне предположений о режиме сечений.

2. В случае осцилязионного режима показывается, что для некоторой последовательности энергий $S_n \to \infty$ имеет место асимптотическое равенство полных сечений.

3. Приводятся необходимые и достаточные условия, того что при любом фиксированном переданном импульсе $t \leq 0$ отношение дифференциальных сечений частиц и античастицы при $S \to +\infty$ стремится соответственно к I, к конечному пределу отличному от I и к ∞ или нулю.

4. Для осцилязионных режимов получается результат, аналогичный указанному в пункте 2^{0}.

5. Выяснена особая роль, которую играет распределение нулей амплитуды в плоскости S .

ON THE ASYMPTOTIC EQUALITY OF THE TOTAL AND DIFFERENTIAL CROSS SECTIONS OF THE PARTICLE AND THE ANTIPARTICLE

N.N.Meiman

Institute of Theoretical and Experimental Physics,
Moscow, USSR

1.The exact proof of the asymptotic equality of particle and antiparticle total cross sections in a wide range of assumptions on the cross section behaviour is given.

2. In the case of oscillation regime it is shown that for definite sequency of the energies $S_n \to \infty$ the asymptotic equality of the total cross sections takes place.

3. The necessary and sufficient conditions for the fact that at any fixed momentum transfer $t \leq 0$ the ratio of the particle and antiparticle cross sections at $S \to +\infty$ tends, respectively to I, to the finite limit differing from I to ∞ or zero.

4. For the oscillation regimes the result analogous to that mentioned in 2 is obtained.

5. A special role of the distribution of the amplitude's zeroes in the plane S is established.

Ш- 5

АСИМПТОТИЧЕСКАЯ АМПЛИТУДА РАССЕЯНИЯ МЕЗОНА НА НУКЛОНЕ

Н.Н. Мейман

Институт теоретической и экспериментальной физики,
Москва, СССР

Вводится вспомогательная амплитуда, асимптотически совпадающая в физической области реакции рассеяния мезона на нуклоне с истинной амплитудой рассеяния. Во всех теориях для доказательства возможности аналитического продолжения амплитуды в комплексную плоскость инвариантной переменной $\underset{\sim}{S}$ при фиксированном переданном импульсе t вводятся весьма сильные добавочные предположения чисто математического характера, не имеющего отношения к физике вопроса. Аналитичность по S при этом доказывается на весьма узком интервале переданных импульсов.

Для асимптотической амплитуды доказывается аналитичность по S исходя лишь из микро-причинности без каких либо добавочных предположений чисто математического характера. Аналитичность имеет место при любом физическом значении $t \leq 0$ переданного импульса. Выясняется неестественность обычно принимаемых математических предположений.

Асимптотическая амплитуда может быть применена во всех вопросах, связанных с изучением асимптотики амплитуды рассеяния. В частности полученные результаты позволяют получать строгий вывод асимптотических равенств полных сечений частицы и античастицы и асимптотического равенства дифференциальных сечений частицы и античастицы при любом переданном импульсе t .

ASYMPTOTIC AMPLITUDE OF MESON-NUCLEON SCATTERING

N.N.Meiman

Institute of Theoreical and Experimental Physics
Moscow, USSR

An auxiliary amplitude is introduced coinciding asymptotically in the physical region of the reaction of meson- nucleon scattering with the real scattering amplitude. In order to prove the possibility of the analytical continuation of the amplitude into a complex plane of the invariant variable S at fixed momentum transfer t in all the theories very strong additional asymptions of purely mathematical nature are introduced having nothing to do with the physics of the problem. The analyticity on S is proved in the very narrow interval of the momentum transfers.

For the asymptotic amplitude the analyticity on S is proved proceeding only from micro-causality without any additional asymptions of purely mathematical character. The analyticity takes place at any physical value $t \leq 0$ of the momentum transfer. The unnatural character of conventional mathematical asymptions is established.

The asymptotic amplitude can be used for the investigation of all the questions concerned with the scattering amplitude asymptotics. In particular, the results obtained make it possible to strictly prove the asymptotic equalities of the particle and antiparticle total cross sections and the asymptotic equality of particle and antiparticle differential cross sections at any momentum transfer t .

ANALYTICITY AND CLUSTER DECOMPOSITION PROPERTIES OF THE S MATRIX IN LOCAL RELATIVISTIC QUANTUM FIELD THEORY

Klaus Hepp

Eidg.Technische Hochschule, Zurich.

In the Wightman framework of a local relativistic quantum field theory Haag and Ruelle have proved the existence of asymptotic scattering states for all irreducible representations $[m,s]$, $m>0$ of the covering group of $iL\uparrow_+$, which are created from the vacuum by quasi-local fields. We shall prove that the scattering amplitudes exhibit spatial cluster decomposition properties describing the fact that the outcome of a scattering process between massive is asymptotically independent of the presence of other particles. If one-particle states to $[m,s]$ are created from the vacuum by a local field, then the well-known analyticity properties of the 2-particle scattering amplitude can be derived under the usual mass-spectrum conditions without the postulate of an L.S.Z. asymptotic condition.

III -7

УРАВНЕНИЯ КВАНТОВОЙ ТЕОРИИ ПОЛЯ В АКСИМАТИЧЕСКОМ ПОДХОДЕ

В.Я. Файнберг

Физический институт им. П.Н. Лебедева
Москва, СССР

Исходя из основных аксиом квантовой теории поля получена система зацепляющихся нелинейных интегродифференциальных уравнений для матричных элементов S - матрицы.

Уравнения не содержат расходящихся выражений. Итерационное решение этих уравнений совпадает с перенормированным рядом теории возмущений.

III-7

EQUATIONS OF THE QUANTUM FIELD THEORY IN THE AXIOMOTIC APPROACH

V.Ya. Fainberg

P.N. Lebedev Physical-Technical Institute

Moscow, USSR

Basing on the principal axioms of the quantum field theory a system of non-linear integral-differential equations is derived for the matrix elements of the S-matrix.

The equations do not comprise divergent expressions. An iterational solution of those equations coincides with a renormalized series of the pertubation theory.

ON THE EXISTENCE OF SOLUTIONS TO THE FIELD EQUATIONS

J.G. Taylor

Cambridge University, England

We discuss the problems of existence and uniqueness of solutions to field equations for local fields. We take as a simple model a spinless scaler meson interacting with itself through a local polynomial term $g\varphi^n$. We write down the equations relating the Green's functions (S matrix elements off the mass shell) in momentum space. There are numerous difficulties in these equations which have to be overcome. The five main ones are (a) ultra-violet divergences, (b) non-linearity, (c) there are an infinite number of equations all coupled together, (d) infinite region of momentum space, and (e) principal value singularities arise from the propagators. We solve (a) for n = 3,4 by taking the Greens function equations directly from "complete unitarity", with differentiations on external momenta for the propagator and vertex equations. We use the Tychonoff fixed point theorem to overcome (b). We avoid (c) by the approximation of neglecting Greens functions with more than a certain number of external lines. We may then remove this approximation by taking an infinite direct product topology on our space of Greens functions. We avoid (d) and (e) by taking momentum vectors in a bounded region of space with a Euclidean rather than Lorentz metric. We may then go to the limit of an unbounded momentum space, and analytically continue in $k_0 \to ik_e$. By this method we obtain analyticity of the resulting solution whose existence is being proved. We obtain results on existence and uniqueness involving all the difficulties except (e) above, for which we give a very suggestive argument. We also discuss the non-renormalisable cases $n > 4$.

СВЯЗЬ ОДНОКРАТНЫХ ИНТЕГРАЛОВ ПРЕДСТАВЛЕНИЯ МАНДЕЛЬШТАМА С ДВОЙНЫМИ СПЕКТРАЛЬНЫМИ ФУНКЦИЯМИ.

Е. Малков

Физико-технический институт, Харьков, СССР.

Показано, что, если амплитуда двухчастичной реакции удовлетворяет условию унитарности ($|a_\ell| \leq 1$) в трех каналах, то к ней нельзя добавить суммы функций, каждая из которых имеет в конечной части комплексного пространства особенности только по одной переменной (s , t или u) и растущих на бесконечности медленнее экспоненты, кроме членов, соответствующих S и p волнам в трех каналах. Это значит, что части амплитуды с особенностями только по одной переменной в конечной области комплексного пространства определяются другой частью амплитуды, содержащей особенности по обеим переменным. Результат является некоторым обобщением результата Фруассара, показавшего, что, если амплитуда удовлетворяет представлению Мандельштама и заданы двойные спектральные функции, то только вычитательные члены, соответствующие S и p волнам, остаются неопределенными. Для случая функции, удовлетворяющей представлению Мандельштама, получено явное выражение однократных интегралов и вычитательного полинома через двойные спектральные функции. Полученная связь необходима, чтобы амплитуда удовлетворяла обычному дисперсионному соотношению, когда переданный импульс фиксирован в физической области (меньше нуля).

CONNECTION BETWEEN SINGLE AND DOUBLE SPECTRAL FUNCTIONS OF THE MANDELSTAM REPRESENTATION

E.Malkov

Physical-Technical Institute, Kharkov, USSR

It is proved that if there is a two-body reaction amplitude satisfying the unitarity condition $(|a_\ell| \leq 1)$ no sum of functions with singularities in finite part of complex space only in one variable (S, t or U) and growing at infinity less that any exponent can be added to it except for terms corresponding to S and P waves in three channels. This means that parts of the amplitude with singularities in finite part of complex space only in one variable are determined by the part containing singularities in both variables. This result is to some extend a generalization of the result of Froissart, who proved that if amplitude satisfies Mandelstam's representation and double spectral functions are fixed only S and P waves subtraction terms are free. For the case of amplitude satisfying Mandelstam representation explicit expressions for single spectral functions and substraction polynomial are derived. The obtained connection between single and double functions is a necessary condition for amplitude to satisfy usual dispersion relation with two substractions when momentum transfer is fixed in physical region (≤ 0) .

III-IO

НЕОДНОЗНАЧНОСТЬ ЭЛЕМЕНТОВ S-МАТРИЦЫ, РЕДУЦИРОВАННЫХ С ПОМОЩЬЮ АСИМПТОТИЧЕСКИХ УСЛОВИЙ

Е.Вичорек, Ф. Кашлун

Институт теоретической физики университета им. Гумбольдта
и Институт физики Высоких энергий Германской
Академии наук, Берлин.

Изучаются редукционные формулы для элементов S-матрицы, полученные при использовании асимптотических условий для взаимодействующих полей для случая вершиной физики в нелокальной теории формфактора. Показано, что можно, в частности, заменить обычную ступенчатую функцию $\theta(x)$, появляющуюся в стандартных интегральных формулах, модифицированной ступенчатой функцией $\theta(x_0 - \alpha|\vec{x}|)$ $0 < \alpha < \frac{\kappa_0}{|\vec{\kappa}|}$ где κ четырехмерный импульс редуцированной частицы в системе покоя другой частицы. Это значит, что для таких модификаций выделена мировая линия редуцированной частицы, а не световой конус. Однако, найдено, что аналитическое продолжение стандартной, также как и модифицированных редукционных формул, приведет к неоднозначным результатам, которые детально изучаются в теории возмущения первого порядка. В заключение рассматривается локальный случай, где выделена редукционная формула с стандартным запаздывающим коммутатором.

NON-UNIQUENESS IN THE S MATRIX REDUCTION BY MEANS OF THE ASYMPTOTIC CONDITION

F.Kaschluhn and E.Wieczorek

Institut für Theoretische Physik der Humboldt-Universitaet Berlin

and Forschugsstelle fur Physik hoher Energien der Deutschen Akademie der Wissenschaften zu Berlin

The reduction formulas for S-matrix elements derived by employing the asymptotic condition on interacting fields are studied for the case of the vertex functions in a non-local form-factor theory. It is shown that one may especially replace the conventional step function $\theta(x)$ appearing in the standard integral formulas by the modified step function $\theta\left(x_0 - \alpha|\vec{x}|\right)$ with $0 < \alpha < \frac{K_0}{|\vec{K}|}$ where K represents the four momentum of the reduced particle in the rest frame of the other one. This means that for such modifications two world--line of the reduced particle but not the light-cone is distinghuished. However, it is found that the analytic continuation of the standard as well as the modified reduction formulas leads to non-unique results which is in detail studied in first-order perturbation theory. Concluding the local case is considered where the reduction formula with the standard retarded commutator is distinghuished.

Ш-II

О ФУНКЦИЯХ ГРИНА СВЯЗАННЫХ СОСТОЯНИЙ

Б.В.Гешкенбейн, Б.Л. Иоффе

Институт теоретической и экспериментальной физики ГКАЭ
Москва, СССР.

Рассматривается нерелятивистская модель, в которой имеется три элементарных частицы a, b, c $a \leftrightarrow b+c$. Частицы b и c взаимодействуют друг с другом с помощью потенциала. Взаимодействие частицы a с частицами b и c учитывается в лагранжиане членом $g\varphi_a^+ \psi_b \psi_c$. Строится функция Грина частицы a и исследуется, что происходит, когда потенциал V взаимодействия частиц b и с таков, что возникает связанное состояние частиц в и с. Исследуется предельный случай, когда сама частица a является связанным состоянием. Изучается возможность релятивистского обобщения рассматриваемой модели.

ON THE GREEN FUNCTIONS OF THE BOUND STATES

B.V.Geshkenbein, B.L.Ioffe
Institute for Theoretical and Experimental Physics
Moscow, USSR

A non-relativistic model in which there are three elementary particles a,b,c $a \rightleftharpoons b + c$ is considered. The particles b and c interact with each other by means of a potential. The interaction of the particle a with the particles b and c is taken into account in the Lagrangian by the term $g\varphi_a^{+}\psi_b\psi_c$. The Green function of the particle a is obtained and the case of the potential leading to the bound state of particles b and c is investigated. The limiting case when the particle itself is a bound state is investigated. The possibility of relativistic generalization of the model under consideration is studied.

Ш-12

ПОЛОСА ВЕРШИННОЙ ФУНКЦИИ И ОРТОГОНАЛИЗАЦИИ ОДНОЧАСТИЧНЫХ СОСТОЯНИЙ

Б.В.Гешкенбейн, Б.Л. Иоффе
Институт теоретической и экспериментальной физики ГКАЭ
Москва, СССР

Исследуется вопрос о наличии полюсов у вершинной функции трех бозонов со спином 0 a, b, c $\Gamma(k^2, m_b^2, m_c^2) \equiv \Gamma(k^2)$ в том случае, когда в канале a имеются два дискретных состояния a_1 и a_2. Показывается, что полюса вершинных функций, которые имеются до ортогонализации состояний a_1 и a_2 исчезают после ортогонализации этих состояний.

III-I2

VERTEX FUNCTIONS POLES AND ONE-PARTICLE STATES ORTHOGONALIZATION

B.V. Geshkenbein, B.L. Ioffe

Institute for Theoretical and Experimental Physics, Moscow, U S S R

The problem of the presence of poles in the vertex function of three bosons with zero spin a, b, c $\Gamma\left(k^2, m_b^2, m_c^2\right) \equiv \Gamma\left(k^2\right)$ is investigated in the case when in the channel a there are two discrete states a_1 and a_2. It is shown that the vertex function poles which are present before the orthogonalization of the states a_1 and a_2 disappear after the orthogonalization of these states.

BOUNDS ON PROPAGATORS, FORM FACTORS AND COUPLING CONSTANTS

S. D. Drell, A. C. Finn, and A. C. Hearn
Stanford University, Stanford, California

Spectral representations for propagators and form factors have been constructed in field theory starting either from the general axioms or from a Feynman graph series. However, little is known about their limiting behaviors for large momenta (subtraction constants) and the magnitudes of the renormalization constants are subjects of considerable conjecture. In this paper we construct several bounds on renormalization constants and on the asymptotic behavior of propagation functions and vertices. The inputs are experimental measurements and/or analyticity properties of vertex functions.

For the photon propagator we prove that if there is no subtraction term the Pauli form factor of the proton, $F_2(q^2)$, must vanish more rapidly than $(\ell n\ q^2)^{-1/2}$ for time like $q^2 \to +\infty$. With no subtractions one can compute the observed vacuum polarization contribution to the Lamb shift and other precision measurements without requiring the introduction of new parameters. Next, we extend techniques developed by Meiman[1] and Geshkenbein[2] and Ioffe in a different but related study, to construct a lower bound rigorous to all orders of the strong interactions on the pionic contribution to the photon's vacuum polarization. With these same techniques a rigorous bound on the nucleon wave function renormalization due to strong interactions, Z_2, and on the nucleon propagator for space like momenta is also constructed. Bounds which can be constructed only after making assumptions on the continuation of amplitudes below physical thresholds are also given for the pion propagator. Finally we discuss the connection between zeros in propagators and values of coupling constants. This is the problem solved by Geshkenbein and Ioffe, and we discuss possible physical significance of such zeros.

[1]N.N. Meiman, JETP 44, 1228 (1963), Soviet Phys. JETP 17, 830 (1963.

[2]B.V. Geshkenbein and B. L. Ioffe, JETP 44, 1211 (1963), Soviet Phys. JETP 17, 820 (1963).

Ш-I4

ОБ ОПРЕДЕЛЕНИИ ЧАСТИЦЫ В ТЕОРИИ ПОЛЯ

Ю.М.Широков

Институт ядерной физики МГУ

Получен следующий результат.

Если: I) оператор поля $A(x)$ определен в некотором произвольном базисе α, т.е. если заданы все матричные элементы $\langle\alpha|A(x)|\alpha'\rangle$; 2) существует S -матрица и 3) все одночастичные матричные элементы $\langle 1|A(x)|1\rangle$ в " in " - базисе не равны нулю (условие типа полноты), то существует однозначная процедура получения I) спектра масс всех частиц; 2) матрицы, связывающей α -базис с " in " -базисом; 3) S -матрицы.

Этот результат содержит определение частиц в теории поля, причем определение не зависит от выбора исходного базиса.

III-14

ON THE DEFINITION OF THE PARTICLES IN THE FIELD THEORY

Yu.M.Shirokov

Institute of Nuclear Physics, Moscow State University, USSR.

The following result has been obtained. If the following conditions hold: (1) the field operator A(x) is defined on some arbitrary basis α , i.e. if all the matrix elements $\langle \alpha | A(x) | \alpha' \rangle$ are given, (2) the S-matrix exists and (3), the one particle matrix elements $\langle 1 | A(x) | 1 \rangle$ in the "in" -basis are not equal to zero for all particles (some sort of completeness), then the unambiguous procedure exists for obtaining: (1) the mass spectrum of all particles; 2) the matrix connecting the given α basis with "in" - basis; 3) the S-matrix.

This result contains the definition of the particles in the field theory. The definition is independent of the choice of the basis.

Ш-I5

О НОВЫХ СВЯЗЯХ МЕЖДУ ПОЛЯМИ И ЧАСТИЦАМИ

Ю.М. Широков

Институт ядерной физики МГУ, СССР

Показано, что матричный элемент $\langle 2|A(x)|2\rangle$ поля $A(x)$ содержит полюсный член. Этот полюс не является одночастичным и расположен вне массовой оболочки. Получен явный вид вычета в этом полюсе. Вычет билинеен по S, S^{+}.

Установление этой новой связи между полями и частицами основано на изучении поведения поля на больших расстояниях и при больших временах. Полученные соотношения являются прямым следствием существования S-матрицы и некоторого условия типа полноты, наложенного на поле.

III-15

ON THE CONNECTIONS BETWEEN FIELDS AND PARTICLES

Yu.M.Shirokov

Institute of Nuclear Physics, Moscow State University.

It is shown that the matrix element $\langle 2|A(x)|2\rangle$ of the field contains the pole term which is of no particle origin and is located outside the mass shell. The corresponding residual is bilinear in the S-matrix and its conjugate.

This new connection between fields and particles was derived on the basis of the investigation of the behaviour of the field at the large space-time distances. The connection is a direct consequence from the existence of the S-matrix combined with some completeness condition imposed on the field.

III-I6

ДИСПЕРСИОННАЯ АНАЛОГИЯ РЕНОРМАЛИЗАЦИОННОЙ ГРУППЫ

Я.Н.Грановский и А.А.Пантюшин

Институт ядерной физики АН Казахской ССР

III-16

A DISPERSION ANALOGY OF THE RENORMALIZATION GROUP

Ya.I.Granovski and A.A.Pantiushin

Institute of Nuclear Physics, Kazakh.SSR

КВАЗИПОТЕНЦИАЛЬНЫЙ МЕТОД В ЗАДАЧЕ ОБ УРОВНЯХ ЭНЕРГИИ СИСТЕМЫ ДВУХ ЧАСТИЦ

Р.Н.Фаустов

Объединенный институт ядерных исследований
Лаборатория теоретической физики
Дубна

Введение комплексного квазипотенциала, зависящего от энергии, позволяет исследовать задачу о связанном состоянии двух частиц с помощью уравнения для волновой функции, близкого к обычному уравнению Шредингера. Квазипотенциал может быть построен (I) по теории возмущений на основе двухвременной функции Грина двух частиц. При этом квазипотенциал носит нелокальный характер, а перенормировка квазипотенциального уравнения аналогична перенормировке S - матрицы. Если ограничиться задачей вычисления энергетических уровней системы, то можно определить локальный квазипотенциал (2) по теории возмущений с помощью матричных элементов амплитуды рассеяния на массовой поверхности. В этом случае оба метода дают одинаковые результаты, однако второй метод обладает существенными преимуществами, так как допускает использование свойств аналитичности и унитарности. Величина расщепления основного уровня энергии позитрония, вычисленная на основе второго метода с точностью до α^5 (α -постоянная тонкой структуры) совпадает со значением, полученным ранее с помощью уравнения Бете-Солпитера. Однако использование квазипотенциального метода значительно облегчает весь расчет. Аналогично вычисляются поправки к уровням энергии водородоподобных атомов.

QUASIPOTENTIAL METHOD IN THE PROBLEM ABOUT THE ENERGY LEVELS OF THE PARTICLE SYSTEM

R.N.Faustov

Joint Institute for Nuclear Research
Dubna, USSR

The itroduction of the complex energy-dependent quasipotential enables one to investigate the problem about the two-particle bound state, using the equation for a wave function similar to the usual Schroedinger equation. The quasipotential can be constructed (1) in the perturbation theory on the basis of the two-time Green function of the two particles. Then the quasipotential is nonlocal and the renormalization of the quasipotential equation is quite analogous to that of the S-matrix. If we limit ourselves to the problem of calculating of the energy levels of the system, then it is possible to determine the local quasipotential (2) in perturbation theory with the help of the matrix elements of the scattering amplitude on the mass shell. In this case both methods yield the same results, however, the second method has some essential advantages, as it makes possible to use analyticity and unitarity. The magnitude of the splitting of the ground energy level of positronium, calculated on the basis of the second method with the accuracy up to α^5 (α is the fine structure constant) coincides with the value obtained with the help of the Bethe-Salpeter equation. However, the utilization of the quasipotential method simplifies considerably the whole procedure. The corrections to the energy levels of the hydrogen-like atoms are calculated in a quite similar manner.

IУ-6

КВАЗИПОТЕНЦИАЛЬНЫЙ МЕТОД В ТЕОРИИ ПОЛЯ

А.А.Логунов, А.Н. Тавхелидзе

Объединенный институт ядерных исследований
Лаборатория теоретической физики

Развит самосогласованный метод введения понятия потенциала в теории поля.

Получено уравнение типа Шредингера для описания системы двух взаимодействующих частиц в квантовой теории поля (квазипотенциальное уравнение).

Изучены общие аналитические свойства квазипотенциала в теории поля, которые на основе квазипотенциального уравнения дают возможность изучить аналитические свойства матрицы рассеяния в комплексной l - плоскости и асимптотические поведения при больших энергиях.

IY-6

QUASIPOTENTIAL APPROACH IN FIELD THEORY

A.A.Logunov and A.N.Tavkhelidze

Joint Institute for Nuclear Research

Dubna

A self-consistent method of introducing the notion of the potential into field theory is developed.

A Schrodinger type equation for describing a system of two interacting particles in quantum field theory (a quasipotential equation) has been obtained.

The general analytic properties of the quasipotential in the field theory have been studied. On the basis of the quasipotential equation, these properties allow to study the analytic properties of the S-matrix in the complex L-plane and its asymptotic behaviour at high energies.

III

SIMPLE LINEAR INTEGRAL EQUATIONS FOR RELATIVISTIC SCATTERING

R.Blankenbecler

and

R.Sugar

Palmer Physical Laboratory , Princeton University,
Princeton, New Jersey U S A

A set of coupled linear integral equations of the Lippman-Schwinger type are presented for relativistic scattering and production processes. The elastic scattering amplitude given by these equations is equal to the corresponding Bethe - Salpeter amplitude if the kernels are chosen appropriately. However, these new equations seem to be more amenable to analytic and numerical discussion than the standard B-S equation. In particular, the partial wave analysis of these equations is considerably simpler and one may discuss inelastic processes.

It is possible to develop upper and lower variational bounds on the phase shifts for any given approximation for the irreducible kernels. As an example, we will discuss an elastic ladder model with non-zero masses and present bounds for the leading Regge tranjectory. In the weak coupling limit we find the standard answer except at threshold, where the tranjectory passes through minus one-half. In the limit of strong coupling we find for below threshold that

$$cg^{2/3} \leq \alpha(s) \leq dg.$$

We believe that the lower bound is actually correct. This is to be contrasted with the zero-mass ladder approximation in the B-S equation where the trajectory actually goes like g in this limit. There seems to be a marked difference between the massive and massless cases. The application of these equations to dynamical calculations will be briefly discussed.

IX

ФИЗИКА СТРАННЫХ ЧАСТИЦ

Эксперимент

STRANGE PARTICLE PHYSICS

Experimental

Strange Particle Production by 3 BeV/c π^- Mesons in Hydrogen

T. P. Wangler, A. R. Erwin, and W. D. Walker
University of Wisconsin, Madison, Wisconsin, U.S.A.

From an analysis of 60,000 pictures of π^- - p interactions at a pion momentum of 3 BeV/c in a hydrogen bubble chamber, over 600 events were identified as strange particle events. Reactions involving two strange particles and as many as four pions were identified on the basis of both kinematical fitting and bubble density information.

The center of mass angular distributions usually show the familiar backward tendency for the baryons and a forward tendency for K mesons. Invariant mass distributions show the production of several resonant states including the Y_1^*(1385 MeV), K^*(885 MeV) and Y_o^*(1405 MeV). The two body reactions

$$\pi^- + p \rightarrow K^* + Y_1^*$$
$$\rightarrow K^* + Y_o^*$$

are also reported and studied.

Evidence is presented for a possible new resonance in the $K\pi\pi$ system at a mass of 1175 MeV.

The two, three, and four particle reactions are discussed and an attempt is made to put limits on the Unitary Symmetry multiplet of the f^o from the number of $K_1^o K_1^o$ events with a mass near the f^o.

The cross sections for the various reactions are calculated and the total strange particle cross section at this energy is estimated to be

$$\sigma = 1.682 \text{ mb} \pm .199 \text{ mb}.$$

ИЗУЧЕНИЕ ПРОЦЕССА РОЖДЕНИЯ Λ -ГИПЕРОНОВ И K^0 МЕЗОНОВ В πp - ВЗАИМОДЕЙСТВИЯХ ПРИ ИМПУЛЬСЕ 4,0 ГЭВ/С

В.П.Банник, Э.Г. Бубелев, В.И.Векслер,
Ким Хи Ин, А.А. Кузнецов, Н.Н.Мельникова,
Г.Л. Резвая, Чадра Б.

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

На основе фотографий, полученных с помощью 24 л. пропановой пузырьковой камеры изучается процесс рождения странных частиц в πp - взаимодействиях при импульсе 4,0 Гэв/с. Дается характеристика рождения Λ -гиперонов и K^0 -мезонов в различных каналах реакций. Приводятся импульсные и угловые характеристики Λ и K^0 -частиц в с.ц.м. и оцениваются сечения их рождения в отдельных реакциях.

Результаты эксперимента обсуждаются с точки зрения модельных представлений.

INVESTIGATION OF THE GENERATION MECHANISN OF Λ^0- HYPERON AND K^0-MESONS IN π^-p INTERACTIONS AT 4.0 GeV/c

B.P.Bannik, E.G.Bubelev, V.I.Veksler, Kim Hi In, A.A.Kusnetsov, N.N.Melnikova, G.L.Resvaja, Chaera B.

Joint Institute for Nuclear Research

Dubna, USSR

On the films obtained at the 24 l. propane bubble chamber, with 4.0 BeV/c π^- beam, the mechanism of strange particle production is investigated.

The production characterstics of Λ^0- hyperons and K^0-meson for different channels of the reactions as well as c.m.s. impulse and angular distributions for Λ^0 and K^0 and partial cross section, are given.

The experimental results are interpreted in the range of different theoretical models.

IX-3

ХАРАКТЕРНЫЕ ОСОБЕННОСТИ ОБРАЗОВАНИЯ ΛK^0 И $K^0\bar{K}^0$-ПАР В $\pi^- p$ ВЗАИМОДЕЙСТВИЯХ ПРИ 7-8 ГЭВ/С

Э.Г.Бубелев и А.А.Кузнецов

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

Образование ΛK^0 и $K^0\bar{K}^0$ пар в $\pi^- p$ - взаимодействиях при 7-8 Гэв/с проанализировано по новой методике. В большинстве случаев определен канал реакции. Изучены характерные особенности разных каналов, в частности, их азимутальная картина. Определены массы мезонных и барионных резонансов, участвующих в этих каналах.

THE CHARACTERISTIC PECULIARITIES OF THE PRODUCTION OF ΛK° AND $K^{\circ}\bar{K}^{\circ}$ PAIRS IN $\pi^{-}p$ INTERACTION AT 7-8 GeV/c

E.G.Bubelev and A.A.Kusnetsov

Joint Institute for Nuclear Research

Dubna, USSR

The production of ΛK° and $K^{\circ}\bar{K}^{\circ}$ pairs in $\pi^{-}p$ interactions at 7-8 GeV/c is analized using the new method. The channel of reaction is defined in most events.

The characteristic peculiarities of different channels particularily their asimuthal picture are investigated.

The masses of mesonic and barionic resonant states participating in these channels are determined.

ИЗУЧЕНИЕ ПРОЦЕССА РОЖДЕНИЯ ΛK^0 и $K^0\tilde{K}^0$ - ПАР В π^-C-ВЗАИМОДЕЙСТВИЯХ ПРИ ИМПУЛЬСЕ (7-8) ГЭВ/С

В.А.Беляков, Н.М.Вирясов, Ким Хи Ин,
А.А.Кузнецов, В.М. Мальцев

Объединенный институт ядерных исследований
Лаборатория теоретической физики
дубна

Исследуется процесс рождения ΛK^0 и $K^0\tilde{K}^0$ -пар в π^- C - взаимодействиях с импульсом (7-8) Гэв/с. Приводятся угловые и импульсные распределения Λ -гиперонов и K^0-мезонов, рожденных в каждой из этих пар и оцениваются сечения рождения пар. Экспериментальные характеристики рождения ΛK^0и $K^0\tilde{K}^0$ - пар сравниваются с результатами расчета каскадов, выполненного по методу Монте-Карло. Дается оценка числа вторичных взаимодействий в ядрах углерода при этих энергиях.

A STUDY OF THE PROCESS OF GENERATION OF ΛK^0 AND $K^0\bar{K}^0$ -PAIRS IN π^-C INTERACTIONS AT (7-8) GeV/c

V.A.Belyakov, N.M.Viryasov, Kim Hi In, A.A.Kusnetsov, V.M.Maltsev

Joint Institute for Nuclear Research

Dubna USSR

The process of generation of ΛK^0 and $K^0\bar{K}^0$ pairs by negative (7-8) GeV/c pions on carbon nuclei is studied. The angular and momentum distributions of Λ hyperons and K^0-mesons from these pairs are given, as well as the cross sections of generations of pairs. The experimental data for the pair generation are compared with the Monte-Carlo calculation of cascades. Estimate of the number of secondary interactions in carbon nuclei at this energy is given.

IX-5

ГЕНЕРАЦИЯ СТРАННЫХ ЧАСТИЦ НА СЛОЖНЫХ ЯДРАХ ПРИ БОЛЬШИХ ЭНЕРГИЯХ

В.А.Беляков, А.В.Бояджиев, Ван Юн-чан, В.И.Векслер, Н.М.Вирясов, Ким Хи Ин, Е.Н. Кладницкая, А.А. Кузнецов, В.М. Мальцев, Нгуен Дин Ты, В.Н.Пенев, М.И. Соловьев

Объединенный институт ядерных исследований

Лаборатория высоких энергий

Дубна

Изучались процессы рождения Λ -гиперонов и K^0-мезонов отрицательными пионами на углероде. Получены угловые и импульсные распределения этих частиц, определено сечение их рождения, оцениваются сечения различных каналов реакций. Впервые сделана оценка доли странных частиц, образованных во вторичных процессах. Проведено сравнение импульсного спектра Λ-гиперонов в системе центра масс пион-нуклон со спектром от π^-- протонных взаимодействий. Экспериментальные данные сравниваются с результатами расчета по каскадной модели, выполненного по методу Монте-Карло.

Расчет сделан для десяти ядер Be_4^9, C_6^{12}, O_8^{16}, F_9^{19}, Al_{13}^{27}, Cl_{17}^{35}, Cu_{29}^{64}, Br_{35}^{80}, Xe_{54}^{131}, Pb_{82}^{207}.

STRANGE PARTICLE PRODUCTION ON COMPLEX NUCLEI AT HIGH ENERGIES

Belyakov V.A., Boyadzhyev A.V., Wang Jung-chang, Veksler V.I., Viryasov B.M., Kim Hi In, Kladnitskaya E.N., Kuznetsov A.A., Maltsev V.M., Nguyen Dihn Tu, Penev V.N., Soloviev M.I.

Joint Institute for Nuclear Research
Dubna, USSR

The production of $\Lambda(\Sigma^{o})$ hyperons and K^{o}-mesons on carbon at the incident π^{-} meson energy of 7 GeV has been investigated. The angular and momentum distributions of these particles have been obtained, their production cross sections has been determined, the cross sections for different channels of the reactions have been estimated. The fraction of strange particles produced in secondary processes has been first estimated. The experimental data are compared with the calculations by the cascade theory. It is shown that the cascade theory is valid for the class of the investigated phenomena. The calculation for ten nuclei / Be^{9}_{4}, C^{12}_{6}, O^{16}_{8}, F^{19}_{9}, Al^{27}_{13}, Cl^{35}_{17}, Cu^{64}_{29}, Br^{80}_{35}, Xe^{131}_{54}, Pb^{207}_{82} / was made.

ИССЛЕДОВАНИЕ ВЗАИМОДЕЙСТВИЙ π^- - МЕЗОНОВ С ИМПУЛЬСОМ 9 ГЭВ/С С ЯДРАМИ КСЕНОНА, СОПРОВОЖДАЕМЫХ РОЖДЕНИЕМ Λ И K^0.

Е.Богданович, Т.Добровольский, Н.А.Ивановская, В.М.Мальцев, Г.И.Пенчев, А. Филипковский

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

На снимках, полученных при облучении 24-литровой ксеноновой камеры П-мезонами с импульсом 9 Гэв/с, отбирались взаимодействия, сопровождаемые V^0- событиями, т.е.распадами $\Lambda^0 \to p + \pi^-$ и $K^0 \to \pi^+ + \pi^-$. Найденные V^0-события измерялись на микроскопе и проводился кинематический анализ с целью идентификации Λ и K^0, а также определении их импульсов и углов вылета по отношению к первичному π^--мезону.

Для отобранных взаимодействий определялось число заряженных частиц и число γ-квантов. Для и K^0 были построены импульсные и угловые распределения в лабораторной системе координат. Эти распределения сравниваются с теоретическими, рассчитанными на основе каскадной модели методом монте-Карло.

Кроме того, проводится сравнение импульсных и угловых распределений Λ и K^0, полученных при взаимодействии с ксеноном, с соответствующими распределениями для водорода в системе центра масс . Из сравнения этих распределений, а также сечений рождения Λ и K^0 на водороде и ксеноне делается оценка доли Λ и K^0, рожденных во вторичных взаимодействиях в ядре .

INVESTIGATION OF 9 GeV/c π^--MESONS WITH Xe NUCLEI INTERACTIONS IN WHICH Λ° AND K° PARTICLES ARE GENERATED

J.Bogdanowicz, T.Dobrowolski, A.Filipkowski, I.A.Ivanovskaja, V.M.Maltsev, G.I.Penchev

Joint Institute for Nuclear Research
Dubna

The films from a 21-liters Xenon Bubble Chamber exposed to a 9 GeV/c π^--meson beam have been scanned for V-events corresponding to $\Lambda^\circ \to p + \pi^-$ or $K^\circ \to \pi^+ + \pi^-$ decays. The selected V-events have been measured by means of a microscope and the results of measurements have been used for finding their momenta and outcoming angles, /i.e. angles between primary meson tracks and Λ° and K° directions of flight/.

The number of charged particles and gamma-quanta produced together with Λ° or K° has been found and also momentum and angular ditributions (in Lab. System) of Λ° and K° have been obtained. The experimental distributions have been compared wi with theoretical ones based on cascade model of interactions and calculated by the Monte-Carlo method.

The experimental momentum and angular distributions (in the centre-of-mass-system of the π -nucleon) for Λ° and K° generated in π^--Xe interactions have been also compared with the corresponding experimental distributions obtained for π^--proton interactions. From the comparison of these distributions and also taking into account the difference in cross-sections for Λ° and K° generation in Xenon and Hydrogen one can estimate the fraction of Λ° and K° created in secondary interactions in Xe nuclei nuclei.

ВОЗМОЖНАЯ СХЕМА ОБРАЗОВАНИЯ Λ-ГИПЕРОНОВ ЧЕРЕЗ ИЗОБАРЫ В π^-p-ВЗАИМОДЕЙСТВИЯХ

В.Ф.Вишневский, Ду Юань-цай, В.И. Мороз,
А.В. Никитин, Ю.А.Троян, Цзян Шао-цзюн,
Чжан Вэнь-юй, Шахбазян Б.А., Янь У-гуан

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

В предположении, что в π^-p- взаимодействиях Λ-гипероны образуются в результате распада изобар, генерируемых с малыми поперечными импульсами, были получены кинематические соотношения между косинусом угла вылета и импульсом рассматриваемых частиц.

Предложенная схема согласуется с известными экспериментальными данными при 7-8, 10 и 16 Гэв/с.

THE POSSIBLE SCHEME OF OFRMATION OF Λ° HYPERONS VIA ISOBARS IN $\pi^{-}p$ INTERACTION

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A.,
Chiang Shaochun, Chang W.Y., Shahbazian B.A.,
Yen Wu-kuang

Joint Institute of Nuclear Research
Dubna, USSR

By assuming that Λ° hyperons are formed as a result of cascade decays of isobars produced with small transverse momentum in $\pi^{-}p$ (or any other two particles) interaction, a kinematic relation has been obtained between the cosine of the emission angle and momentum of the particle (i.e. Λ° here) observed.

Such a proposed scheme has been found in agreement with the experimental results obtained for Λ° hyperons produced in $\pi^{-}p$ interaction at 7-8, 10 and 16 GeV/c .

Production of Strange Particles in π^+ - p Collisions at 1.39, 1.76, and 2.08 GeV/c*

H. W. J. Foelsche, H. L. Kraybill, C. Y. Chien, and A. Lopez-Cepero
Yale University
(to be presented by H. D. Taft)

We have identified 668 two-pronged reactions producing strange particles at π^+p momenta of 1.39, 1.76, and 2.08 GeV/c. The angular distributions of the reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ will be presented. Production of the Y_1^* at 1385 MeV is observed at 1.76 and 2.08 GeV/c, in the reaction $\pi^+ + p \rightarrow \Lambda^o + K^+ + \pi^+$, with very low background. The width of the Y_1^* at these two energies was determined to be $32 \pm \frac{7}{6}$ MeV and $26 \pm \frac{8}{6}$ MeV, respectively. Cross-sections for reactions producing $\Sigma^+K^+\pi^o$, $\Sigma^oK^+\pi^+$ are consistent with charge independence. The K*(885 MeV) is observed in the reactions producing $\Sigma^+K^+\pi^o$ and $\Sigma^+\pi^+K^o$. No definite evidence of other resonances has been found. Partial cross-sections will be given for each energy. Decay angular distributions of the Y_1^* will be presented.

STRANGE PARTICLE PRODUCTION BY 8 GeV/c π^+ IN HYDROGEN

CERN - Warsaw

About 100,000 photographs of 8 GeV/c positive pions in the Saclay 81cm hydrogen bubble chamber have been scanned for events in which two strange particles were observed to decay. Results will be presented on the analysis of some 250 such events. In particular, the variation of transverse momentum with particle mass will be discussed and the interactions will be analysed in terms of a "principal axis of collision" as has been introduced in the study of strange particle production by 10 GeV/c negative pions.

Production of Ξ Hyperons by 5 Bev/c K^- Mesons *

V.E. Barnes, B.B. Culwick, J.L. Lloyd, R.B. Palmer,
D. Radojicic, C.R. Richardson, N.P. Samios, J.R. Smith

Brookhaven National Laboratory
Upton, N.Y.

and

M. Goldberg, B. Goz, M. Gundzik, N. Horwitz,
J.Leitner, M.Primer, R. Wolfe

Syracuse University
Syracuse, N.Y.

The Brookhaven National Laboratory 80" liquid hydrogen bubble chamber has been exposed to a mass-separated beam of 5.0 Bev/c K^- mesons at the Brookhaven AGS. An analysis of the first 100,000 pictures shows that the total sample of the film should contain about 300 cases of Ξ^- and Ξ^0 hyperon production. The K^- beam path length is such that one obtains 5 events of a given kind per microbarn of K^- -p interaction cross section.

The observed Ξ hyperons are produced in association with 2, 3 or 4 mesons, the effective mass of the hyperon-meson system ranging up to 3.18 Bev/c^2. Results of a detailed analysis of the total sample of events will be presented.

Threshold Phenomena in the Reaction $K^- + p \rightarrow \Lambda + \eta^*$

P.L. Connolly, E.L. Hart, D.C. Rahm,
D.L. Stonehill, B. Thevenet,[+] W.J. Willis, S.S. Yamamoto
Brookhaven National Laboratory, L.I., New York

We have observed that the cross section for the reaction $K^- + p \rightarrow \Lambda + \eta$ rises to the order of one millibarn within a few MeV above threshold, then decreases very rapidly. We attempt to explain this behavior, as well as the cross section for $K^- + p \rightarrow \Sigma^o + \pi^o$, by means of a K-matrix analysis with constant matrix elements.

IX-I2

Strange Particle Production in P - P Collision At 5.5 Gev/c

G. Alexander, O. Benari, N. Kidron, A. Shapira
R. Ya'ari and G. Yekutieli

Department of Nuclear Physics, The Weizmann Institute of Science-Rehovoth.

The production of strange particles has been studied in p - p collision at 5.5 Gev/c using the 81 cm hydrogen bubble chamber at CERN. About 180 events have been found with a visible strange particle decay. Using these events a total and differential cross section values will be given for the various production modes. Contribution to the strange particle production from resonances will be discussed.

Strange Particle Production in 10 GeV/c Proton-Proton Collisions

by S. Nilsson and T. Olhede
Institute of Physics
University of Stockholm

The Sacley 81 cm hydrogen bubble chmaber has been exposed to 10 GeV/c protons. About 20.000 pictures have been scanned for interactions with two observed strange particles. 62 events have been found, of those 27 events with V^oV^o, 22 with V^+V^o, 7 V^-V^o, 2 V^+V^+ and 4 V^+V^-. Average number of charged prongs is 2.9 for V^oV^o events and 2.6 for V^+V^0 events. Cross-sections for hyperon-kaon and kaon-kaon production will be given. The results on hyper-kaon and kaon-kaon correlations will be discussed.

IX-I4

ИССЛЕДОВАНИЕ ПРОЦЕССОВ РОЖДЕНИЯ Λ-ГИПЕРОНОВ И K^0 МЕЗОНОВ В np - ВЗАИМОДЕЙСТВИЯХ

В.Ф.Вишневский, Ду Юань-цай, В.И.Мороз,
А.В.Никитин, Ю.А.Троян, Цзян Шао-цзюн,
Чжан Вэнь-юй, Шахбазян Б.А., Янь У-гуан

Объединенный институт ядерных исследований
Лаборатория высоких энергий
Дубна

Процессы рождения Λ-гиперонов и K^0-мезонов в np - взаимодействиях исследуются при помощи 24-х литровой пропановой пузырьковой камеры, облученной коллимированным нейтронным пучком с импульсом вплоть до II Гэв/с в постоянном магнитном поле 15200 гаусс.

Процессы рождения изучаются не только по обычной методике, но и по схеме образования Λ-гиперонов и K^0 - мезонов через изобары (например, через $Y_1^*(1385)$ и $N_3^*(1688)$ и т.д.). Последняя схема согласуется с известными экспериментальными данными образования Λ-гиперонов в $\pi^- p$ - взаимодействиях при энергиях до 16 Гэв.

INVESTIGATION OF THE PROCESSES OF PRODUCTION OF HYPERON AND K^0 MESONS IN N-P INTERACTION

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A., Chiang Shaochun, Chang W.Y., Shahbazian B.A., Yen Wu-kuang

Joint Institute for Nuclear Research
Dubna, USSR

For the study of production mechanism of Λ^0 and K^0 particles in n-p interaction, the experimental materials are being obtained from about 140000 pictures already taken with a 24 litre propane chamber placed in a constant field of 15200 gauss and irradiated with a collimated neutron beam having momentum up to 11 GeV/c.

The processes of such production are being investigated not only by the ordinary method, but also by the scheme of production of Λ^0- hyperons and K^0 mesons via isobars (e.g. via Y_1^* (1385) and N_3^* (1688), and so on). This last scheme has been found to be in agreement with the experimental results for hyperons produced in π^- p interaction with energy up to 16 GeV.

Hyperon Pair Production in 7 Bev/c $\bar{p}p$ Reactions*

C. Baltay, C. Y. Chien, J. Lach, J. Sandweiss†, P. Slattery, and H. Taft
Yale University
and
J. K. Kopp, Y. Oren, A. M. Thorndike, and M. S. Webster
Brookhaven National Laboratory
(to be presented by H. D. Taft)

An exposure of the B. N. L. 80 inch liquid hydrogen bubble chamber to an electrostatically separated beam[1] of 7 Bev/c anti-protons has been obtained recently at the Brookhaven A. G. S. A total of 10^6 meters of path length was photographed. These pictures are being analyzed for two body hyperon pair production final states of the type

$$\Lambda\bar{\Lambda},\ \Lambda\bar{\Sigma}^o,\ \bar{\Lambda}\Sigma^o,\ \Sigma^{\pm}\bar{\Sigma}^{\pm},\ \text{and}\ \Xi^-\bar{\Xi}^-$$

There is also recent data with improved statistics on these final states at 3.69 Bev/c $\bar{p}$ momentum. In these reactions the antihyperons tend to be produced forward in the center of mass system, suggesting peripheral exchange mechanisms. There are indications[2] that K* exchange is more dominant than K exchange in the $\Lambda\bar{\Lambda}$ and $\Lambda\bar{\Sigma}^o$ or $\bar{\Lambda}\Sigma^o$ pairs.

A detailed analysis of these pair productions will be presented at 7 Bev/c, and a comparison with the 3.69 Bev/c data will be made. Comparisons with possible production models based on SU3 will also be attempted.

* Research carried out under the auspices of the U. S. Atomic Energy Commission.

† Alfred P. Sloan Foundation Fellow

1. I. Skillicorn and M. Webster, Status Report on a High Energy Separated Beam for the 80" Chamber, Brookhaven National Laboratory Internal Report No. H-10.
2. Loyal Durand III and Yam Tsi Chiu, Phys. Rev. Letters 12, 399 (1964).

A Search for the Ω Hyperon in 7 Bev/c $\bar{p}p$ Collisions*

C. Baltay, C. Y. Chien, T. Ferbel, H. L. Kraybill, J. Lach,
J. Sandweiss†, H. D. Taft, and N. Yeh
Yale University
and
D. J. Crennell, J. K. Kopp, Y. Oren, D. L. Stonehill, A. M. Thorndike, and
M. S. Webster
Brookhaven National Laboratory
(to be presented by H. D. Taft)

A search is underway for the production of the Ω hyperon in 7 Bev/c antiproton-proton collisions, utilizing a total of 10^6 meters of antiproton path in the BNL 80 inch liquid hydrogen bubble chamber. The antiprotons were obtained in an electrostatically separated beam[1] at the Brookhaven AGS.

The search is sensitive to a singly charged, strangeness - 3 baryon with mass between 1460 and 1820 Mev, and a lifetime between $\sim 10^{-11}$ and $\sim 10^{-9}$ seconds. The decay modes into ΛK, $\Xi^-\pi^0$ and $\Xi^0\pi$ were considered.

At the present time the analysis of about 1/3 of the data has been completed, but no example of Ω production has been found. This implies an upper limit of ~ 5 μb for Ω production in 7 Bev/c $\bar{p}p$ collisions. Results based on the complete analysis of the 10^6 meters of $\bar{p}$ path will be presented.

* Research carried out under the auspices of the U. S. Atomic Energy Commission.

† Alfred P. Sloan Foundation Fellow.

1. I. Skillicorn and M. Webster, Status Report on a High Energy Separated Beam for the 80" Chamber, BNL Internal Report No. H-10.

Pion and kaon production in antiproton-neutron annihilations at rest.

V.Barnes and K.Lai (B.N.L.)
P.Anninos, L.Gray; P.Hagerty, E.Harth, T.Kalogeropoulos, S.Zenone (Syracuse University)
R.Bizzarri, U.Dore, G.Gialanella, P.Guidoni, G.C.Moneti,(Roma University)

Partecipant: R.Bizzarri

Sc.Establishements: Brookhaven National Laboratory
Syracuse University
Istituto di Fisica Università di Roma e Sezione di Roma dell'I.N.F.N.

Frequencies were obtained for various antiproton-neutron annihilation channels involving pion and kaon.
The data were obtained from an exposure of the BNL 32" senterium Bubble Chamber to a stopping antiproton beam.
The results are compared with the statistical model.
In addition the ratio of antiproton-neutron and antiproton-proton annihilation will be present.

Production of Hyperons and Antihyperons in Antiproton-Nucleon Interactions*

T. C. Bacon, H. W. K. Hopkins, D. K. Robinson, E. O. Salant
Brookhaven National Laboratory, Upton, Long Island, New York

and

A. Engler, H. E. Fisk, C. M. Meltzer and J. B. Westgard
Carnegie Institute of Technology, Pittsburgh, Pennsylvania

The deuterium-filled Brookhaven National Laboratory 20-inch bubble chamber was exposed to a separated beam of 2.8 BeV/c antiprotons; approximately 75,000 pictures were obtained. Mesons, hyperons and antihyperons, produced with and without additional pions in both $\bar{p}n$ and $\bar{p}p$ interactions, are observed. Emphasis of the study is on hyperon-antihyperon production in $\bar{p}n$ interactions.

---

* Work performed under the auspices of the U. S. Atomic Energy Commission.

$y\hat{y}$ PRODUCTION BY 5.7 GeV/c ANTIPROTONS IN HYDROGEN

R.Bock, A.Cooper, B.R.French, R.Levisetti
CERN Geneva
D.Revel, B.Tallini, S.Zylberajch
C.E.N., Saclay

Polarization of Λ hyperons in Associated Photoproduction.* D.E. Groom and J.H. Marshall, California Institute of Technology. -- The polarization of Λ hyperons in the reaction $\gamma + p \rightarrow K^+ + \Lambda$ has been measured, using the CalTech synchrotron. The measurements were made at 90° in the c.m., at laboratory photon energies from 1100 to 1300 MeV. Protons from the asymmetric decay of the Λ were detected in a counter system in coincidence with the K^+. The kaon was detected in a 16 to 18 counter telescope in which it stopped. If preliminary logic was satisfied, all pulse heights from counters in the telescope were digitized and recorded on paper tape, along with the relevant coincidence information. A detailed fit to the Bragg curve was made in a digital computer to establish the identification. Results are in agreement with earlier work at Cornell[1], but the energy range has been extended. Results at 1100; 1200; and 1300 MeV will be presented.

* This work was supported in part by the U.S. Atomic Energy Commission.

[1] H. Thom, E. Gabathuler, D. Jones, B.D. McDaniel, and W.M. Woodward, Phys. Rev. Letters 11, 433 (1963).

IX-2I

Masses of the Λ and Σ Hyperons *

P. SCHMIDT, C.A. STEINBERGER, J. STEINBERGER and D.TYCKO

Columbia University, New York, New York

Precision mass measurements of the Λ, Σ^+, Σ^o and Σ^- hyperons will be reported on the basis of 10 different measurements performed on the annihilation of K^- mesons in hydrogen. These will be compared with predictions of the SU_3 model.

---

* Work supported in part by the U. S. Atomic Energy Commission.

A New Determination of the Masses of Σ^- and Σ^0 Hyperons*

R. A. Burnstein, T. B. Day, B. Kehoe,

B. Sechi-Zorn and G. A. Snow

University of Maryland, College Park, Maryland, U.S.A.

The low energy K^- beam at the Cern PS stopping in the 81 cm Saclay hydrogen bubble chamber yielded many examples of the at rest reactions (1) $K^- + p \rightarrow \Sigma^- + \pi^+$, (2) $\Sigma^- + p \rightarrow \Lambda^0 + n$ and (3) $\Sigma^- + p \rightarrow \Sigma^0 + n$, $\Sigma^0 \rightarrow \Lambda^0 + e^- + e^+$. In this note, the mass of the Σ^- hyperon is determined to be 1197.0 $\pm$ 0.2 MeV in terms of the better known masses of the other particles in reactions (1) and (2), by measuring the momentum via range of stopping Σ^- in (1) and the momentum of the Λ^0 in reaction (2). The (Σ^-, Σ^0) mass difference is determined to be 4.8 $\pm$ 0.1 MeV from the value of the Σ^0 momentum in reaction (3).

*Work supported in part by U. S. Atomic Energy Commission

PRELIMINARY RESULTS ON THE Λ^0 MAGNETIC MOMENT

Emulsion groups of Bristol, CERN, Lausanne and Munich

Emulsion stacks were used for the detection of Λ^0 particles which had been produced in a polythene target bombarded by negative pions of 1.05 GeV/c. The whole arrangement was in a pulsed magnetic field of 150 kgauss. Preliminary results on the Λ^0 magnetic moment as derived from the angular distribution of the decay pion will be given.

Measurement of the Lambda Magnetic Moment*

D. A. Hill and K. K. Li
Laboratory for Nuclear Science
Massachusetts Institute of Technology, Cambridge, Mass.
and
E. W. Jenkins, T. F. Kycia, and H. Ruderman
Brookhaven National Laboratory, Upton, N. Y.
(Presented by T. F. Kycia)

ABSTRACT

The magnetic moment of the Λ^o hyperon has been measured at the Brookhaven Cosmotron. Polarized Λ^o hyperons were produced by 1.02 ± 0.015 GeV/c π^+ mesons incident on a Be target in the reaction $\pi^+ + n \rightarrow \Lambda^o + K^+$. The precession of the Λ^o polarization by a longitudinal magnetic field was detected by observing the rotation of its asymmetric decay distribution in a parallel plate spark chamber. The magnetic field was produced by a liquid-nitrogen-cooled magnet, pulsed for 40 msec. at 2.6 sec. repetition rate, giving an average field integral of about 500 kgauss-cm. The detection system was divided into two halves, each covering an azimuthal angle of 180°, one half to detect the Λ^o decay and the other the K^+ meson. The selected events were required to have a charged decay from a neutral particle on the Λ^o-side, and a coincident K^+ on the K-side. The K^+ mesons were identified by velocity, specific ionization, and finally by their decay. The Λ^o production and decay geometry was recorded by photographing spark chambers in which the decay proton and/or the decay π^--meson were stopped in order to facilitate momentum determination. The kinematics at both the production and decay vertices were thus determined, so that the production plane could be well defined even in the presence of the target Fermi momentum. A total of about 7,000 measurable events have been accumulated, giving an expected uncertainty in the Λ^o magnetic moment of ±0.15 nuclear magneton. Preliminary results will be presented.

---

* Work performed under the auspices of the U. S. Atomic Energy Commission.

SOME PROPERTIES OF THE Ξ^- HYPERON*

Philippe Eberhard, Janice Button-Shafer, and Deane W. Merrill
(Presented by George R. Kalbfleisch)

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 12, 1964

ABSTRACT

We report here the parameters for Ξ^- hyperons from newly obtained events in the 72-inch hydrogen bubble chamber exposed to a 2- to 3-GeV/c K^- beam.

---

*Work sponsored by the U. S. Atomic Energy Commission.

Lifetimes of Helium Hypernuclei*

R. J. Prem and P. H. Steinberg

University of Maryland, College Park, Maryland, U.S.A.

An estimate for the lifetime of ${}_{\Lambda}He^{5}$ of $1.4^{+1.9}_{-0.5} \times 10^{-10}$ seconds, is obtained from three decays in flight and twenty-five decays at rest through the mode:

${}_{\Lambda}He^{5} \rightarrow He^{4} + p + \pi^{-}$, found in an emulsion stack exposed to 2.3 - 2.5 BeV/c K^{-} mesons at the Brookhaven AGS. Also one decay in flight and nine decays at rest of ${}_{\Lambda}He^{4} \rightarrow He^{3} + p + \pi^{-}$ were observed in a total estimated time of 1.50×10^{-10} seconds.

These data are combined with previously reported[1,2] lifetime values for undifferentiated samples of ${}_{\Lambda}He^{4,5}$ to obtain a value, $1.3^{+0.5}_{-0.3} \times 10^{-10}$ seconds.

*Work supported in part by U. S. Atomic Energy Commission

(1) R. G. Ammas et al, Phys. Letters 3, 340(1963)

(2) Y. W. Kang et al, Phys. Rev. Letters, 10, 302(1963)

Mass of the Ω^- Hyperon and Cross Section for its Production by 5 BeV/c K^- Mesons*

V.E. Barnes, P.L. Connolly, D.J. Crennell, B.B. Culwick
W.B. Fowler, E.L. Hart, N. Horwitz †, P.V.C. Hough,
J.K. Kopp, K.W. Lai, J. Leitner†, J.L. Lloyd,
G.W. London‡, T.W. Morris, Y. Oren, R.B. Palmer,
A.G. Prodell, D. Radojicic, D.C. Rahm, C.R. Richardson,
N.P. Samios, J.R. Smith,
R.C. Strand, A.M. Thorndike
Brookhaven National Laboratory, Upton, L.I., New York

The BNL 80" hydrogen bubble chamber was exposed to a mass separated beam of 5.0 BeV/c K^- mesons at the Brookhaven AGS. A total of ~200,000 pictures were taken with a total K^- track length of 5×10^6 feet corresponding to a yield of five events per microbarn cross section. The pictures contain 1000 events which are candidates for Ω^- production in that these events have topologies appropriate to the following decay modes of the Ω^-

$$\Omega^- \rightarrow \Xi^- + \pi^0 \quad (A)$$
$$\Omega^- \rightarrow \Xi^0 + \pi^- \quad (B)$$
$$\Omega^- \rightarrow \Lambda^0 + K^- \quad (C)$$

In a detailed analysis of the first 300 candidates we have identified two Ω^- events, the first one decaying via mode B and the second via mode C. A preliminary value for the mass of the Ω^- is 1674 ± 3 MeV and an estimate of the production cross section is two microbarns. Results of analysis of the total sample will be presented.

*Work performed under the auspices of the U.S. Atomic Energy Commission.

†Syracuse University, Syracuse, New York
‡University of Rochester, Rochester, New York

TENTATIVE DATA ON STRONGLY INTERACTING STATES

A.H.Rosenfeld

University of California Radiation Laboratory,
Berkeley, California, USA

Low Momentum Interactions of Σ - Hyperons With Protons and a New Measurement of the $(\Sigma^- - \Sigma^+)$ and $(\Sigma^- - \Sigma^o)$ Mass Differences

R. Engelmann, H. Filthuth[a], E. Kluge, V. Hepp, A. Minguzzi-Ranzi[b]

University of Heidelberg, Germany

In the CERN stopping K^- - experiment about 8.10^5 hyperons are produced. Part of the film has been scanned for hyperon-proton interactions, $\Sigma^\pm p \rightarrow \Sigma^\pm p$, $\Sigma^- p \rightarrow (\Sigma^o, \Lambda^o) n$. Cross sections are given in the Σ - momentum interval 0 - 170 Mev/c. From about 40 $\Sigma^- p \rightarrow \Sigma^o n$, $\Sigma^o \rightarrow \Lambda^o e^+ e^-$ events the $(\Sigma^- - \Sigma^o)$ mass difference has been determined. The $(\Sigma^- - \Sigma^+)$ mass difference is derived from a few thousand at rest reactions $K^- p \rightarrow \Sigma^\pm \pi^\mp$, $\Sigma^\pm \rightarrow n \pi^\pm$.

a) At University of Heidelberg, Germany and at CERN, Geneva, Switzerland

b) At University of Bologna, Italy

K^- - p Interactions at Low Energy *

J. KIM and M. NUSSBAUM

Columbia University, New York, New York

The reactions

$$K^- + p \rightarrow K^- + P$$

$$K^- + p \rightarrow K^o + n$$

$$K^- + p \rightarrow \Lambda^o + \pi^o$$

$$K^- + p \rightarrow \Sigma^o + \pi^o$$

$$K^- + p \rightarrow \Sigma^+ + \pi^-$$

$$K^- + p \rightarrow \Sigma^- + \pi^+$$

have been investigated experimentally in the region of K^- momenta below 200 MeV/c. Results obtained on the basis of approximately 6000 measured events will be presented.

---

* Supported in part by the U. S. Atomic Energy Commission.

K^--p Interactions from 830 to 960 MeV/c*

G. R. Charlton, P. E. Condon, R. Uhlig, M. Whatley and G. B. Yodh

University of Maryland, College Park, Maryland, U.S.A.

A. Aitken, R. Glasser and A. J. Herz

U. S. Naval Research Laboratory, Washington, D. C., U.S.A.

The following reactions

$$K^- + p \rightarrow \Lambda + \pi^0$$

$$K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$$

$$K^- + p \rightarrow \bar{K}^0 + n$$

$$K^- + p \rightarrow \bar{K}^0 + p + \pi^-$$

are being studied in the 30" BNL hydrogen bubble chamber in a 13 kg field. Exposures were carried out at nominal momenta of 830, 880, 910, 740 and 960 MeV/c and a total of 180,000 pictures were taken with approximately 8 K^- per picture. Results based on some 3500 events will be presented.

*Work supported in part by U. S. Atomic Energy Commission

K^- - Neutron Interactions Between 1600 MEV and 1700 MEV

Marcel Schneeberger and Sanford E. Wolf
Brandeis University, Waltham, Massachusetts
John Albright and Joseph E. Lannutti
Florida State University, Tallahassee, Florida

The meson-baryon system with quantum numbers I=1, Y=0 is being studied over the energy region 1600 to 1700 Mev total barycentric energy. Data on the reactions

$$K^- + n \rightarrow \begin{cases} \Lambda^0 + \pi^- \\ \Lambda^0 + \pi^- + \pi^0 \\ \Sigma^0 + \pi^- \end{cases}$$

will be presented, and the effects in these channels of the recently observed resonance at 1660 Mev will be discussed. This experiment is part of an exposure of the Brookhaven-Columbia 30" deuterium filled bubble chamber to a separated K^- beam over the range 300 to 500 Mev.

THE K^-p CHARGE-EXCHANGE REACTION AT 2.45, 2.63, AND 2.70 GeV/c*

Angela Barbaro-Galtieri and Robert D. Tripp
(Presented by George R. Kalbfleisch)

Department of Physics and Lawrence Radiation Laboratory
University of California, Berkeley, California

At present a K^- path length of about 0.6 μb/event has been measured at 2.45 GeV/c and an equivalent amount is being measured at 2.63 and 2.70 GeV/c as part of the current 72-inch hydrogen bubble chamber experiment. The cross sections and angular distributions for the reaction $K^-p \to \bar{K}^0 n$ at these momenta are presented and discussed. Qualitatively the angular distribution appears strongly forward peaked, the backward peaking observed[1] at 1.22 GeV/c having completely disappeared.

---

*Work sponsored by the U. S. Atomic Energy Commission.

1. M. Ferro-Luzzi, F. T. Solmitz, and M. L. Stevenson, in Proceedings of the 1962 International Conference on High Energy Physics at CERN (CERN, Geneva, 1962).

PRELIMINARY RESULTS OF K^--PROTONS INTERACTIONS AT 6 GeV/c

Bubble Chamber film analysis groups of Birmingham and Glasgow Universities, Imperial College London, Oxford University and Rutherford Laboratory.

The Charge Exchange $K^- + p \rightarrow K^o + n$ at 10 Gev

P.Astbury, G.Finocchiaro, A.Michelini, C.Verkerk
CERN
W.Beusch, B.Gobbi, M.Pepin, M.Pouchon, E.Polgar
ETH Zürich
D.Websdale, C.West, Imperial College, London

500 K^- charge exchange events were produced in ahydrogen target, the decay of the K_1^o being observed in a magnet spark chamber. This spark chamber has a useful volume of 60x80x170 cm^3 and is placed in a 10.7 kG magnetic field. Charge exchange events are unambiguously defined. The apparatus covers a range of the squared momentum transfer from 0 to 4 $(Gev/c)^2$.
Total and differential cross-sections will be given. The differential cross-section exhibits forward peaking but less pronounced than is observed in K^-p elastic scattering.

SEARCH FOR THE REACTIONS $K^- + p \rightarrow \Lambda \mu^+ \mu^-$ AND $\Lambda e^+ e^-$ AT 2.45 AND 2.70 GeV/c*

Angela Barbaro-Galtieri and Robert D. Tripp

(Presented by Ronald R. Ross)

Department of Physics and Lawrence Radiation Laboratory
University of California, Berkeley, California

May 12, 1964

ABSTRACT

As part of the current 72-inch hydrogen bubble-chamber experiment using the K^- beam at the Bevatron, approximately 15 000 events of the topology of one V and a two-prong have been processed. Of these events, 70% fit the lambda hypothesis for the V. A selected sample of these lambda events has been fitted to the reactions $K^- + p \rightarrow \Lambda \mu^+ \mu^-$ and $K^- + p \rightarrow \Lambda e^+ e^-$. Results are discussed and compared to theoretical predictions.

---

*Work sponsored by the U. S. Atomic Energy Commission.

STUDY OF THE K^+p AND K^+d REACTION FROM 0.85 TO 1.5 BeV/c*

Roger W. Bland, Michael G. Bowler, John L. Brown,
Gerson Goldhaber, Sulamith Goldhaber, John A. Kadyk,
Victor H. Seeger, and George H. Trilling

(Presented by Sulamith Goldhaber)

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 15, 1964

ABSTRACT

An experiment on the K^+p and K^+d reaction in the 25-in. bubble chamber is in progress at the Bevatron. In this momentum region, $\sigma(K^+p)$ varies from ~ 12 to ~ 18 mb. The inelastic processes giving rise to this increase are being studied and will be discussed.

---

*Work sponsored by the U. S. Atomic Energy Commission.

K^+p ELASTIC SCATTERING AT 3.0 AND 3.5 GeV/c

J. Debaisieux, F. Grard, J. Heughebaert, L. Pape and R. Windmolders
Laboratoire des Hautes Energies, Bruxelles

M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V.P. Henri, B. Jongejans, D.W.G. Leith, G.R. Lynch, F. Muller , J.-M. Perreau
CERN , Geneva

G. Otter and P. Sällström - Institute of Physics, Stockholm

In a study of K^+p interactions from an exposure of the Saclay 80 cm hydrogen bubble chamber to a separated beam of 3.0 and 3.5 GeV/c K^+, about 1000 elastic scattering events have been identified and processed at each energy. The shape of the diffraction peak is given for $0.02 \leq -t \leq 1.0$ $(GeV/c)^2$. These results are correlated with the existing data at other momenta. A rapid change of slope of the diffraction peak with increasing incident momentum is observed and will be discussed.

K^+p INTERACTIONS AT 5.0 GeV/c

S.P.Almeida, H.W.Atherton, T.A.Byer, P.J.Dornan, A.G.Forson,
J.H.Scharenguivel, D.M.Sendall, B.A.Westwood

Cambridge University, Cavendish Laboratory, England

The 81 cm Saclay hydrogen chamber has been exposed to a separated K^+ beam of 5.0 GeV/c incident momentum. The reaction $K^+ p \rightarrow K^+ p \pi^+ \pi^-$ is being studied and the results obtained from a preliminary analysis of about 700 events are presented.

Some production and decay properties of observed resonances are discussed.

Low Momentum Λ^o-p Elastic Scattering Cross Section*

B. Sechi-Zorn, R. A. Burnstein, T. B. Day,
B. Kehoe, and G. A. Snow
University of Maryland, College Park, Maryland, U.S.A.

Film containing about 15,000 Λ^o's, produced by (K^-,p) reactions at K^- momenta from 0 to about 200 MeV/c in the Saclay hydrogen bubble chamber, has been carefully scanned twice for evidence of Λ^o-p scatterings. 61 Λ^o-p events have been found and measured, yielding the following cross sections:

$\bar{p}_{\Lambda^o}$ (Lab)	σ (mb)
140 MeV/c	187 ± 65
202 MeV/c	171 ± 31
248 MeV/c	92 ± 22
310 MeV/c	49 ± 19

More data and a comparison with low energy scattering parameters deduced from hyperfragment binding energies will be presented.

*Work supported in part by the U. S. Atomic Energy Commission

Please place this abstract adjacent to the abstract entitled "Low Momentum Interactions of Σ^+ and Σ^- Hyperons with Protons"

Low Momentum Λ^op Scattering

G. Alexander, U. Karshon, A. Shapira, G. Yekutieli

Weizmann Institute of Science
Rehovoth, Israel

R. Engelmann, H. Filthuth, A. Fridman*, A. Minguzzi-Ranzi**

University of Heidelberg
Germany

and

CERN
Geneva, Switzerland

The CERN stopping K^--film was scanned for Λ^o-p elastic scattering interactions. Cross sections from about 100 - 300 Mev/c Λ^o-momentum are presented.

* On leave from University of Strasbourg, France

** University of Bologna, Italy

IX-42

ИЗУЧЕНИЕ УПРУГОГО РАССЕЯНИЯ Λ ГИПЕРОНОВ И K^0 МЕЗОНОВ НА ПРОТОНАХ

В.Ф.Вишневский, Ду Юань-цай, Мороз В.И.,
А.В.Никитин, Ю.А.Троян, Цзян Шао-цзюн,
Чжан Вэнь-юй, Шахбазян Б.А., Янь У-гуан.

Объединенный институт ядерных исследований
Лаборатория высоких энергий

Для изучения упругого рассеяния Λ-гиперонов и K^0-мезонов на протонах использовалась 24-х литровая пропановая пузырьковая камера, облучаемая коллимированным пучком нейтронов с энергией от ~2 до 10 Гэв в постоянном магнитном поле напряженностью в 15200 гс. Отбирались события, в которых V^0- частицы рождались и взаимодействовали с протонами в объеме камеры.

Всего было получено около 140000 стереоснимков.
Из них на 40000 было отобрано для измерений и идентификации около 50 событий типа упругого рассеяния V^0- частиц.

Рассматриваются распределения по углам рассеяния и некоторые другие характеристики.

STUDY OF ELASTIC SCATTERING OF Λ^0 AND K^0 PARTICLES BY PROTONS

Vishnevsky V.F., Du Yuan-tsai, Moroz V.I., Nikitin A.V., Trojan Yu.A., Chiang Shaochun, Chang W.Y., Shahbazian B.A., Yen Wu-kuang

Joint Institute for Nuclear Research
Dubna, USSR

For the study of elastic scattering of Λ^0 and K^0 particles by protons, a 24 litre propane bubble chamber in a constant magnetic field of 15200 gauss has been irradiated with a collimated neutron beam having energy up to 10 GeV. The V^0-particles produced interact with protons in the same chamber.

About 140000 pairs of stereoscopic pictures have been taken. From 40000 pictures about 50 events of the V^0p elastic scattering type have been selected for measurement and identification. The distributions of scattering angles and other characteristic quantities are to be studied in some details after accumulating reasonable statistics.

Low Momentum Interactions of Σ^+ and Σ^- Hyperons with Protons*

R. A. Burnstein, T. B. Day, B. Kehoe, H. A. Rubin,
B. Sechi-Zorn and G. A. Snow

University of Maryland, College Park, Maryland, U.S.A.

In the film from the CERN stopping K^- meson experiment in the Saclay hydrogen bubble chamber, we have carefully scanned more than 10,000 Σ^+ and Σ^- hyperons for evidence of interactions in flight with protons. Events of type $\Sigma^\pm + p \rightarrow \Sigma^\pm + p$ and $\Sigma^- + p \rightarrow (\Lambda^o, \Sigma^o) + n$ have been found. The following cross sections for these reactions in the Σ momentum interval about 125-170 MeV/c have been found:

$$\sigma\ (\Sigma^+ + p \rightarrow \Sigma^+ + p) = 200 \pm 100 \text{ mb.}$$

$$\sigma\ (\Sigma^- + p \rightarrow \Sigma^- + p) = 300 \pm 80 \text{ mb.}$$

$$\sigma\ (\Sigma^- + p \rightarrow (\Lambda^o, \Sigma^o) + n) = 400 \pm 100 \text{ mb.}$$

More data and a comparison with SU_3 predictions[1] will be presented.

* Work supported in part by the U. S. Atomic Energy Commission

[1] P. D. DeSouza, G. A. Snow and S. Meshkov, Md. Tech. Report No. 361 and Physical Review, to be published.

Please place this abstract adjacent to the abstract entitled "Low Momentum Λ^o -p Elastic Scattering Cross Section"

A Study of $\pi^- + P \rightarrow K_1^o + K_1^o + n$ Reaction at 6 Bev/c*

V.E. Barnes, W.B. Fowler, K.W. Lai, D. Radojicic,
D.C. Rahm, M.S. Webster
Brookhaven National Laboratory
Upton, L.I.,N.Y.

A total of 60,000 pictures have been obtained in an exposure of the BNL 80-inch hydrogen bubble chamber to a 6 Bev/c negative pion beam at the AGS. A study of the effective mass spectra of (K_1^o, K_1^o), $(K_1^o\ n)$ and the angular distribution of recoil nucleons in $\pi^- + p \rightarrow K_1^o + K_1^o + n$ reaction will be presented. Possible production mechanisms will also be discussed.

*Work performed under the auspices of the U.S. Atomic Energy Commission.

*) also related to Section XIII

Proton-Proton Scattering at 10 GeV/c

S. P. Almeida, H. W. Atherton, T. A. Byer, P. J. Dornan, A. G. Forson,
J. H. Scharenguivel, D. M. Sendall, B. A. Westwood,

Cambridge University, Cavendish Laboratory, England

About 1000 interactions producing 4 charged secondaries have been analysed. These are from an exposure in the 81 cm Saclay H.B.C. taken at CERN. The final states containing two nucleons will be discussed, with particular reference to isobar formation and the peripheral model. Cross-sections for other production processes will also be given.

K^--p INTERACTION NEAR 1 BeV/c

Robert W.Birge, Robert Bell, Robert P.Ely, Jr.,
Sun Yiu Fung

Lawrence Radiation Laboratory, University of California,
Berkeley, California, USA

We are studying the K^--p interaction at 50 MeV/c intervals between 850 MeV/c and 1150 MeV/c with pictures taken in the new 25-inch hydrogen bubble chamber at the Lawrence Radiation Laboratory. Angular distributions are being studied throughout this reginn to verify the quantum numbers of the 1815 MeV resonance and the possible existence of the 1765 MeV resonance.

The Reaction $K^- + p \rightarrow \Sigma\pi\pi$ at 1.34 BeV/c*

W. P. Swanson, J. R. Fiebiger, R. I. Hulsizer, and W. P. Trower
Physics Department, University of Illinois, Urbana, Illinois

Participant who will present paper - E. L. Goldwasser

This paper describes the second phase of the experiment described in the previous abstract. The reactions studied are:

$$K^- + p \rightarrow \Sigma^- + \pi^+ + \pi^o \qquad \text{(146 events)} \qquad (1)$$

$$\Sigma^+ + \pi^- + \pi^o \qquad \text{(151 events)} \qquad (2)$$

We see evidence for Y_o^* (1405) and Y_o^*(1520) production in these reactions. We are determining the mean values of the masses, the partial cross sections, and the decay properties of the resonances. More measurements are currently being made in order to reduce the statistical fluctuations in the mass plots. An attempt will then be made to observe the more weakly-produced resonances. A comparison with the results of other experiments at nearby energies[1] will be made.

*This work performed under auspices of the U.S. Atomic Energy Commission and the National Science Foundation.

[1] M. H. Alston, et al., Proc. Intern. Conf. High Energy Physics, CERN, 311(1962); W. A. Cooper, et al., Proc. Intern. Conf. High Energy Physics, CERN, 298(1962); Barbaro-Galtieri, et al., Bull. Am. Phys. Soc., Ser. II, 9, 23(1964), and private communication.

EDITOR: Please have this paper follow "Some Two Body Final States of the K^--Proton Interaction at 1.34 BeV/c", by W. P. Trower et al.

*) also related to Section XIII

Abstract of paper to be presented at the Dubna, Russia Meeting, August 5-15, 1964.

IX*) -48

Some Two-Body Final States of the K^--Proton Interaction at 1.34 BeV/c*

W. P. Trower, R. I. Hulsizer, and W. P. Swanson.
Physics Department, University of Illinois, Urbana, Illinois.

May 12, 1964

Participant who will present paper - E. L. Goldwasser

Using an SMP, we have scanned and measured some 20,000 stereo triads of film produced by the 72-inch Alvarez Group hydrogen Bubble Chamber. The reactions we wish to report here are

$$K^- + p \rightarrow \bar{K}^o + n;\ \bar{K}^o \rightarrow \pi^+ + \pi^- \quad \text{(159 events)} \quad (1)$$

$$\rightarrow \Lambda + \pi^o \quad \text{(238 events)} \quad (2)$$

$$\rightarrow \Sigma^- + \pi^+ \quad \text{(81 events)} \quad (3)$$

$$\rightarrow \Sigma^+ + \pi^- \quad \text{(170 events)} \quad (4)$$

Other interactions in this film have already been reported elsewhere. We determine the differential cross section and the integrated partial cross section for interactions (1) through (4). The angular distribution of the decay product of the final-state baryon for interactions (2) through (4) is being analyzed. Some conclusions from these data are drawn as they relate to each other and similar experiments at nearby energies[1]. Additional measurement is in progress.

*Work performed under the auspices of U.S. Atomic Energy Commission and National Science Foundation.

[1] For Example, M. L. Stevenson et al., Bull. Am. Phys. Soc., Ser. II, 9, 441(1964); C. Wohl et al., Bull Am. Phys. Soc., Ser. II, 9, 442(1964); A. Barbaro-Galtieri et al., Bull. Am. Phys. Soc., Ser. II, 9, 23(1964); P.M. Dauber, Phys. Rev. (to be published); M. Ferro-Luzzi, Proc. Intern. Conf. High Energy Physics, CERN, 316(1962).

EDITOR: Please have this paper preceed "The Reaction $K^- + p \rightarrow \Sigma\pi\pi$ at 1.34 BeV/c", by W.P. Swanson et al.

*) also related to Section XIII

PRODUCTION OF S=0, -1 RESONANT STATES IN K^-p INTERACTIONS AT 2.45 GeV/c*

Luis W. Alvarez, Angela Barbaro-Galtieri, Janice Button-Shafer, Orin I. Dahl, Jerome Friedman, Stanley Flatte, Philippe Eberhard, William E. Humphrey, George R. Kalbfleisch, James S. Lindsey, Deane W. Merrill, Joseph J. Murray, Alan Rittenberg, Ronald R. Ross, Frank T. Shively, Daniel M. Siegal, Gerald A. Smith, and Robert D. Tripp

(Presented by Ronald R. Ross)

Department of Physics and Lawrence Radiation Laboratory
University of California, Berkeley, California

May 12, 1964

ABSTRACT

About 70,000 pictures of 2.45-GeV/c K^-p interactions have been obtained in the present 72-inch hydrogen bubble-chamber experiment. Each picture contains six or seven negative K mesons incident on hydrogen, which yields a total pathlength of ~2 events/μ barn. The π^- contamination is one or two π^- per picture. Approximately 15,000 events of all topologies except 1-, 2-, and 3-prong events have been measured and remeasured. Effective mass distributions of two or more particles in the final state show production of resonant states to be an important contribution to cross section. Cross sections and angular distributions for production of some of the known meson and baryon resonances are reported.

---

*Work sponsored by the U. S. Atomic Energy Commission.

*) also related to Section XIII

Resonance Production in the Reaction $K^- p \to K^- p \pi^+\pi^-$ at 2.63 and 2.70 BeV/c*

M. Pripstein, J. R. Ficenec, R. I. Hulsizer, D. W. Mortara, W. P. Swanson, and W. P. Trower

Physics Department, University of Illinois, Urbana, Illinois

We report here results on the reaction $K^- p \to K^- p \pi^+\pi^-$ at 2.63 and 2.70 BeV/c, based on a study of approximately 60,000 pictures of K^--p interactions in the Berkeley 72-in. liquid hydrogen bubble chamber. Events having a 4-prong topology were measured with an SMP on line with the University of Illinois CSX-1 computer. The analysis indicates that the reaction $K^- p \to K^- p \pi^+\pi^-$ is produced primarily via a three-body intermediate state, as follows:

$$K^- + p \to \left\{ \begin{matrix} K^{0*} + \pi^- + p \\ K^- + \pi^- + N^*_{33}\ (1238) \end{matrix} \right\} \to K^- + p + \pi^+ + \pi^-,$$

with the production of the K* and N^*_{33} resonances peaked at low momentum transfers. Decay distributions of these resonances will be presented and production mechanisms of these resonances will be discussed. The effective-mass plot of the (K^-,p) system indicates the presence of some Y^*_0 (1815) with a full-width-at-half-maximum of the order of 60 MeV.

*Work performed under the auspices of the U.S. Atomic Energy Commission and the National Science Foundation.

*) also related to Section XIII

IX*) - 51

PRODUCTION OF $\Xi K(n)\pi$, $\Lambda K\bar{K}(n)\pi$, AND $\Sigma K\bar{K}$ FINAL STATES IN K^--p INTERACTIONS AT 2.45 TO 2.70 GeV/c*

Gerald A. Smith, James S. Lindsey, and Joseph J Murray
(Presented by Ronald R. Ross)

Lawrence Radiation Laboratory
University of California
Berkeley, California

The 72-inch hydrogen bubble chamber has been exposed to a separated beam of K^- mesons at incident momenta of 2.45, 2.55, 2.64, and 2.70 GeV/c. Approximately 475 000 pictures with 6 to 7 K^- and 1 to 2 π^- per picture have been taken in the approximate ratio 1:1:3:2 at each of the respective momenta. Scanning and measuring of $\Xi K\pi$, $\Xi K\pi\pi$, $\Lambda K\bar{K}$, $\Lambda K\bar{K}\pi$, and $\Sigma K\bar{K}$ reactions have yielded 518, 85, 426, 26, and 31 events, respectively. These numbers represent approximately two-thirds of the total available data. Production of Ξ^*(1530 MeV), ϕ(1020 MeV), and K^*(890 MeV) is observed in these events over this range of momenta. A detailed discussion of the dominant characteristics of these reactions and the possible existence of new strangeness -2 baryon states of mass less than 2 GeV is presented.

---

* Work sponsored by the U. S. Atomic Energy Commission.

*) also related to Section XIII

STUDY OF THE REACTION $K^+p \rightarrow K^+p\pi^+\pi^-$ AT 3.5 GEV/C

J. Debaisieux, F. Grard, J. Heughebaert, L. Pape and R. Windmolders

Laboratoire Hautes Energies, Institut Inter-universitaire des Sciences Nucléaires, Brussels, Belgium.

In the study of 3.5 GeV/c K^+ interactions in hydrogen about 400 events corresponding to the reaction $K^+p \rightarrow K^+p\pi^+\pi^-$ have been identified and analysed.

The events originate from an exposure of the Saclay 80cm hydrogen bubble chamber to a separated K^+ beam at CERN. The results show an abundant production of $K^*(890)$ and $N^*(1238)$ with a large fraction of events (approximately 50 °/o) with K^* produced in association with N^*.

The production angular distributions show the characteristic behaviour of a peripheral mechanism.

The values of the production and decay parameters will be discussed and compared to the CERN results at 3 GeV/c.

*) also related to Section XIII

THE REACTION $K^+p \to K^0p\pi^+$ ABOVE 3 GeV/c

M.Ferro-Luzzi, R.George, Y.Goldschmidt-Clermont,
V.P.Henri, B.Jongejans, D.G.W.Leith, G.R.Lynch,
F.Miller and J.M.Perreau

CERN, Geneva

HYPERON PRODUCTION BY 3 and 3.5 GeV/c K^+

M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V.P. Henri, B. Jongejans, D.W.G. Leith, G. Lynch, F. Muller and J.M. Perreau

CERN, Geneva, Switzerland

Results will be presented on reactions of the type $K^+ p \longrightarrow K K Y$ ($Y = \Lambda, \Sigma$) and $K^+ p \longrightarrow K K Y \pi$, at incident K^+ lab. momenta of 3 and 3.5 GeV/c. A study of the effective-mass spectra, in particular for the $S = +2$ K K system, will be presented, together with cross sections and angular distributions.

*) also related to Section XIII

PRODUCTION MECHANISM OF K^{*} and N^{*} RESONANCES BY 3.5 and 5 GeV/c K^{+}

M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V.P. Henri, B. Jongejans, D.W.G. Leith, G. Lynch, F. Muller and J.M. Perreau

CERN, Geneva, Switzerland

The 3 - body reaction

$$K^{+} p \longrightarrow K^{o} \pi^{+} p$$

at these momenta is found to be dominated by the production of either the K^{*+} or the N^{*++} resonances. A detailed analysis of the two reactions

$$K^{+} p \longrightarrow K^{*+} p$$
$$K^{+} p \longrightarrow K^{o} N^{*++}$$

for K^{+} incoming momenta of 3.5 and 5 GeV/c shows the peripheral nature of these reactions and allows to draw conclusions relative to the nature of the exchanged particle.

*) also related to Section XIII

ОПРЕДЕЛЕНИЕ ОТНОСИТЕЛЬНОЙ ЧЕТНОСТИ $\Sigma^{\pm}$, K^{+} В РЕАКЦИЯХ НА ПОЛЯРИЗОВАННЫХ ПРОТОНАХ

В.И.Лущиков, К.Д.Толстов

Объединенный институт ядерных исследований, Дубна, СССР

В работе[I] показано, что в двухчастичных реакциях, когда спины I/2 и 0, например: $\pi^{\pm} + p \to \Sigma^{\pm} + K^{+}$ асимметрия влево-вправо вылета гиперона под углом θ к направлению пучка равна: $\varepsilon(\theta) = \pm P_p \cdot P_{\Sigma}(\theta)$ где P_p – поляризация протона, $\bar{P}_{\Sigma}$ – поляризация гиперона. Знак плюс соответствует сохранению внутренней четности. В опыте для определения относительной четности $\Sigma^{\pm}$, K^{+} предполагается измерить асимметрию влево-вправо для K^{+} – мезонов, образуемых на динамически поляризованных протонах. Учитывая ядерный состав кристалла $La_2Mg_3(WO_3)_{12}(H_2O)_{24}$ и возможные значения $\bar{P}_p$ и $\bar{P}_{\Sigma}$ величина $\varepsilon(\theta) = 0,1$. Следовательно, чтобы определить знак асимметрии, когда статистические флюктуации втрое меньше эффекта необходимо зарегистрировать 1000 K^{+}. Опыт предполагается в пучках $\pi^{\pm}$ мезонов с энергией $\sim$ I Гэв при регистрации K^{+} фотоэмульсиями.

DETERMINATION OF THE $\Sigma^{\pm}, K^{+}$ RELATIVE PARITY ON POLARIZED PROTONS

V.I.Luschikov, K.D.Tolstov

Joint Institutef for Nuclear Research

Dubna