

CERN 65-24
Volume III.
14 February 1966

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

PROCEEDINGS OF THE 1965 EASTER SCHOOL FOR PHYSICISTS

Using the CERN Proton Synchrotron
and Synchro-Cyclotron

Bad Kreuznach, April 1 - 15, 1965

Volume III.
Lectures by:
L. Van Hove
W. Heisenberg
D. H. Perkins
K. Winter

G E N E V A

1966

© Copyright CERN, Genève, 1966

Propriété littéraire et scientifique réservée pour tous les pays du monde. Ce document ne peut être reproduit ou traduit en tout ou en partie sans l'autorisation écrite du Directeur général du CERN, titulaire du droit d'auteur. Dans les cas appropriés, et s'il s'agit d'utiliser le document à des fins non commerciales, cette autorisation sera volontiers accordée.

Le CERN ne revendique pas la propriété des inventions brevetables et dessins ou modèles susceptibles de dépôt qui pourraient être décrits dans le présent document; ceux-ci peuvent être librement utilisés par les instituts de recherche, les industriels et autres intéressés. Cependant, le CERN se réserve le droit de s'opposer à toute revendication qu'un usager pourrait faire de la propriété scientifique ou industrielle de toute invention et tout dessin ou modèle décrits dans le présent document.

Literary and scientific copyrights reserved in all countries of the world. This report, or any part of it, may not be reprinted or translated without written permission of the copyright holder, the Director-General of CERN. However, permission will be freely granted for appropriate non-commercial use. If any patentable invention or registerable design is described in the report, CERN makes no claim to property rights in it but offers it for the free use of research institutions, manufacturers and others. CERN, however, may oppose any attempt by a user to claim any proprietary or patent rights in such inventions or designs as may be described in the present document.



SCIENTIFIC ORGANIZING COMMITTEE

Dr. R. Armenteros	(CERN)
Prof. H. Ehrenberg	(University of Mainz)
Dr. K. Gottstein	(Max-Planck Institut für Physik, Munich)
Dr. W.O. Lock	(CERN)
Dr. U. Meyer-Berkhout	(DESY, Hamburg)
Miss E.W.D. Steel	(CERN)
Prof. M. Teucher, Chairman	(DESY, Hamburg)
Prof. L. Van Hove	(CERN)

EDITORIAL BOARD FOR THE PROCEEDINGS

Dr. K. Gottstein	(Max-Planck Institute für Physik, Munich)
Dr. W.O. Lock	(CERN)

PREFACE

The first part of the present Volume III of the Proceedings of the 1965 Easter School held at Bad Kreuznach contains the lectures given by L. Van Hove on SU_3 and SU_6 symmetry of strong interactions. The first draft of these lectures was prepared by F.O. Weyer-Menkhoff on the basis of notes prepared by Professor Van Hove and of the tape recordings of the lectures; the final text was edited by Professor Van Hove.

Following these lectures this Volume contains an abstract of the lecture delivered by W. Heisenberg on applications of Goldstone's theorem on electrodynamics and on other problems concerning the spectrum of elementary particles. The substance of this lecture is widely covered by a paper recently published by H.P. Dürr, W. Heisenberg, H. Yamamoto and K. Yamazaki in *Il Nuovo Cimento*. With the kind permission of the editors of *Il Nuovo Cimento*, we therefore include the text of the latter paper.

The last part of this volume contains the lectures given by Professor D.H. Perkins and Dr. K. Winter. We are grateful to these speakers for kindly providing us with the manuscripts of their talks.

We are grateful to the authors for their co-operation in preparing the manuscripts and checking the typed texts. Our thanks are also due to Miss S. Bloch and Miss M. Hutin for their careful typing; Mr. P. Theurillat and his colleagues of the Scientific Information Service, and Miss A. Lutke and Mrs. D. Bader of the MSC Drawing Office for their preparation of certain figures; also to Mrs. K. Wakley for her careful checking of the final text.

Editorial Board

CONTENTS

L. Van Hove

SU₃ AND SU₆ SYMMETRY OF STRONG INTERACTIONS

I. SU ₃ SYMMETRY	1
1) Three-dimensional spinor calculus, the group SU ₃ and its representations	1
2) The main multiplets of hadrons	8
3) Infinitesimal transformations. Operators for isospin and hypercharge	11
4) Transformation of operators under SU ₃	14
5) Mass splitting operator. Mass formula of Gell-Mann and Okubo	15
6) Electromagnetic properties. U spin	21
7) Coupling between baryons and pseudoscalar mesons	26
II. SU ₆ SYMMETRY	26
1) Non-relativistic spin and the group SU ₂	26
2) The group SU ₆	28
3) SU ₆ multiplets of hadrons	30
4) SU ₆ predictions for baryon interactions	35
5) Definition of quarks	39
BIBLIOGRAPHY	40

H.P. Dürr, W. Heisenberg, H. Yamamoto, K. Yamazaki

QUANTUM ELECTRODYNAMICS IN THE NON-LINEAR SPINOR THEORY
AND THE VALUE OF SOMMERFELD'S FINE STRUCTURE CONSTANT

ABSTRACT	43
I. THE SCALE TRANSFORMATION (DILATATION GROUP)	44
II. THE EIGENFUNCTION OF THE PHOTON	45
III. THE EIGENVALUE EQUATION OF THE PHOTON	48
IV. SOME REMAINING PROBLEMS CONCERNING THE LEPTONS, PHOTONS, AND WEAK INTERACTIONS	52
APPENDIX	54
REFERENCES	63

D.H. Perkins
NEUTRINO PHYSICS

I. INTRODUCTION	65
II. BASIC PROPERTIES OF NEUTRINOS	66
III. PROBLEMS RELATING TO LEPTON CURRENTS	68
IV. NEUTRINO INTERACTIONS. PHYSICS PROBLEMS RELATING TO WEAK BARYON CURRENTS	74
V. TECHNICAL INNOVATIONS	79
VI. NEUTRINOS FROM SPACE AND FROM REACTORS	82
REFERENCES	84
FIGURE CAPTIONS	86

K. Winter
CP INVARIANCE

I. INTRODUCTION	87
II. $K^0 - \bar{K}^0$ SYSTEM	88
III. TWO-PION DECAY OF THE LONG LIVED K^0	90
1) Identification of the decay products	91
2) Identification of the decaying particle	91
3) Apparent violation of CP invariance	91
4) Experiments	92
5) Violation of CP invariance	95
REFERENCES	99
FIGURE CAPTIONS	100