

Contents

Dynamical Groups and their Currents. A Model for Strong Interactions A. O. BARUT	1
Current Algebra and Lightlike Charges H. LEUTWYLER	29
Introduction to the Lagrangian Method V. F. MÜLLER	42
Introduction to the Method of Current Algebra H. PIETSCHMANN	53
S-Matrix Formulation of Current Algebra H. PILKUHN	65
Electromagnetic Mass Differences J. ROTHLEITNER	71
Nonleptonic Decays and Mass Differences of Hadrons B. STECH	84
Current Algebra in the Framework of General Quantum Field Theory P. STICHEL	100
Current Algebra and Renormalizable Field Theories P. STICHEL	110
Introduction to Current Algebra P. STICHEL	120
Realisations of a Compact, Connected, Semisimple Lie Group J. WESS	132
Problems in Vector Meson Theories W. ZIMMERMANN	143

Dynamical Groups and their Currents

A Model for Strong Interactions

A. O. BARUT

Contents

1. Preliminaries	1
1.1 The Algebraic Description of Particle States and of Currents	1
1.2 Development of the Algebraic Theory of Strongly Interacting Particles	4
1.3 The $O(4,2)$ -Models	5
1.4 Notations	5
2. The General Theory	6
2.1 The Group $O(4,2)$ and the Physical Interpretation of its Generators	6
2.2 States with Momentum P_μ and the Full Algebra	8
2.3 Conserved Currents	9
3. The $O(4,2)$ -Formulation of the Dirac Theory and its Generalizations	11
4. The $O(4,2)$ -Formulation of the Interactions of the H-Atom	13
5. The $O(4,2)$ -Model of Proton	18
5.1 Basic Hypotheses	18
5.2 Matter Current and Mass Spectrum	19
5.3 The Electromagnetic Current	20
5.4 The Scalar Vertex	21
5.5 Diffraction Scattering	22
5.6 Model for the Proton	23
5.7 The Inclusion of Internal Quantum Numbers	24
5.8 The Weak Vertex	26
6. Conclusions	26
References	27

Current Algebra and Lightlike Charges

H. LEUTWYLER

Contents

1. Introduction	29
2. Charge Algebra	30
3. Infinite Momentum	31
4. Virtues of the Lightlike Charges	33
5. Quark Model	34
6. Local Transformation Properties	37
7. Weinberg Sum Rules	39
References	40

Introduction to the Lagrangian Method

VOLKHARD F. MÜLLER

Contents

1. Introduction	42
2. Noether's Theorem	43
3. Electrodynamics and Gauge Transformations	46
4. Generalized Yang-Mills Theories	47
References	52

Introduction to the Method of Current Algebra

H. PIETSCHMANN

Contents

1. Introduction	53
2. General Survey of the Method	53
3. The Adler-Weisberger Sum Rule	55
4. Semi-Leptonic K-Meson Decays	59
5. Sum-Rules for Spectral Functions	60
References	64

S-Matrix Formulation of Current Algebra

H. PILKUHN

Contents

1. Strong Interactions	65
2. Weak Interactions	68
References	70

Electromagnetic Mass Differences

J. ROTHLEITNER

Contents

1. Introduction	71
2. The Problem of Nonrelativistic Coulomb-Shift and its Solution by "Mass"-Renormalisation	72
3. The Electromagnetic Mass Shift of Hadrons	75
a) The Cottingham Formula	75
b) The Single Particle (Elastic) Contribution to the Electromagnetic Mass-Shift	76
4. The Connection Between the Asymptotic Behaviour of the "Compton"-Amplitude and Equal Time Commutators of the Electromagnetic Current	78
5. On a Possible Connection of the $I=1$ Electromagnetic Mass Differences with the Nonleptonic Weak Decays	82
References	83

Nonleptonic Decays and Mass Differences of Hadrons

B. STECH

Contents

1. Introduction	84
2. Nonleptonic Decays.	85
3. Octet Dominance and the Structure of Weak Interaction	95
References and Remarks	98

Current Algebra in the Framework of General Quantum Field Theory

P. STICHEL

Contents

1. Introduction	100
2. Definition of Charges and Generalized Charges	101
3. Formulation of Equal-Time Limits	104
3.1 ETC for Charges Respectively Generalized Charges	104
3.2 ETC for Currents	105
3.3 Choice of Admissible δ -Sequences $\{f_T\}$	105
4. Gradient Terms	106
4.1 c -Number Gradient Terms	106
4.2 q -Number Gradient Terms	109
References	109

Current Algebra and Renormalizable Field Theories

P. STICHEL

Contents

1. Introduction	110
2. Interactions and Currents	111
3. Equal-time Commutation Relations of Axial Charges in Second Order Perturbation Theory	112
3.1 One Particle Matrix Elements	112
3.2 Many Particle Matrix Elements	115
3.3 Further Remarks on Currents and Interactions	116
4. Equal-time Commutation Relations of Currents in First Order Perturbation Theory	117
5. Concluding Remarks	118
References	119

Introduction to Current Algebra

P. STICHEL

Contents

1. Introduction	120
2. The Role of Current Algebra within Present Elementary Particle Physics	120
3. $SU(3) \times SU(3)$ Algebra of Currents	122
4. The Adler-Weisberger Relation	125
5. General Sum Rule à la Fubini	127
6. Low Energy Theorems	128
References	130

Realisations of a Compact, Connected, Semisimple Lie Group*

JULIUS WESS

Contents

Introduction and Explanations	132
Relations between Linear and Nonlinear Transformations	139
References	142

Problems in Vector Meson Theories

W. ZIMMERMANN*

Contents

I.	One Massive Vector Field Coupled to a Conserved Current	143
1.	The Proca-Wentzel Formulation	143
2.	Indefinite Metric Formulation	147
3.	Gauge Invariance	148
4.	Derivation of the Johnson Sum Rule	148
5.	Finite Formulation of Field Equations	149
6.	Current-Field Relation	151
II.	Two Vector Fields Coupled to the Same Current	152
1.	Two Massive Vector Fields	152
2.	Conventional Model of the Electromagnetic Field and a Vector-Meson Field Coupled to the Same Current	153
3.	Kroll-Lee-Zumino Model	154
	Footnotes and References	156