



## **Contents**

Spectroscopy of Light Nuclei by Low Energy ( $< 70$  MeV) Inelastic Electron Scattering

H. THEISSEN

Nuclear Isobar Configurations

H. ARENHÖVEL and H. J. WEBER

Experiments on Electroproduction  
in High Energy Physics

K. HEINLOTH



# Spectroscopy of Light Nuclei by Low Energy (< 70 MeV) Inelastic Electron Scattering

HORST THEISSEN

## Contents

1. Introduction . . . . .	1
2. Experimental Apparatus and Method . . . . .	2
2.1. Historical Remarks . . . . .	2
2.2. Experimental Installation . . . . .	3
2.3. Experimental Problems . . . . .	4
3. Data Reduction and Analysis . . . . .	8
3.1. Determination of Peak Areas . . . . .	8
3.2. Calibration of Inelastic Cross Sections . . . . .	15
3.3. Inelastic Cross Section in Plane Wave Born Approximation . . . . .	16
3.4. Distorted Wave Born Approximation, Correction Factors . . . . .	21
3.5. Determination of Reduced Transition Probabilities and Transition Radii . . . . .	22
4. Discussion of Individual Transition Types . . . . .	25
4.1. Electric Monopole Transitions . . . . .	25
4.2. Pure Electric Quadrupole Transitions . . . . .	36
4.3. Pure Magnetic Dipole Transitions . . . . .	40
4.4. Transitions of other Multipolarity . . . . .	43
4.5. Mixed Transitions . . . . .	44
5. Survey of Results, Systematics . . . . .	46
5.1. Table of Results, Comparison with Results of other Methods . . . . .	46
5.2. Transition Radii . . . . .	48
6. Conclusion . . . . .	49
References . . . . .	51

# Nuclear Isobar Configurations\*\*\*

H. ARENHÖVEL and H. J. WEBER

## Contents

Abstract . . . . .	58
1. Introduction . . . . .	58
2. Treatment of Isobars in Nuclei . . . . .	61
2.1. The Meaning of Isobars in Nuclei: Formalism and Problems . . . . .	61
2.2. Isobar Wave Functions . . . . .	66
2.3. Transition Amplitudes and Potentials . . . . .	70
3. Applications . . . . .	74
3.1. Backward Elastic Proton-Deuteron Scattering . . . . .	74
3.2. Forward Proton Production in Pion-Deuteron Collisions . . . . .	78
3.3. Isobar Corrections to Electromagnetic Properties . . . . .	81
3.4. The Role of Isobars in Nuclear Beta Decay . . . . .	86
4. Conclusion and Outlook . . . . .	88
5. References . . . . .	90



# Experiments on Electroproduction in High Energy Physics

K. HEINLOTH

## Contents

1. Introduction . . . . .	93
2. The Essence of Meson Electroproduction . . . . .	93
3. Description of the Cross Section Formulas Used and Brief Discussion of the Radiative Corrections . . . . .	95
3.1. Connection between the Variables of the Measurement and the Cross Section to be Determined . . . . .	95
3.2. Radiative Corrections . . . . .	100
4. Experimental Data on the Total Cross Section of Virtual-Photon Absorption . . . . .	100
4.1. On the Proton . . . . .	100
4.2. Absorption Cross Section on the Neutron . . . . .	106
4.3. Absorption Cross Section on Heavy Nuclei . . . . .	108
5. Discussion of the Data on the Total Cross Section of Virtual-Photon Absorption under the Aspect of Models of Nucleon Structure . . . . .	109
5.1. Classical Field Model of Nucleon Resonances [15] . . . . .	109
5.2. Parton Model [16] . . . . .	110
Consideration about the Mass of the Parton . . . . .	112
Considerations about the Average Number and Charge of the Partons . . . . .	113
Considerations about the Spin of the Partons . . . . .	114
6. Experimental Data on Differential Cross Sections of Meson Production with Virtual Photons . . . . .	115
6.1. Electroexcitation of the First Nucleon Resonance [20, 21] . . . . .	116
6.2. Electroproduction of a Single $\pi^+$ -Meson on a Proton [23–26] . . . . .	118
6.2.1. $t$ -Dependence of the Differential Cross Sections for Fixed Values of $W$ and $q^2$ . . . . .	118
6.2.2. $q^2$ -Dependence of the Differential Cross Sections for Fixed Values of $W$ and $t$ . . . . .	118
6.2.3. $W$ -Dependence of the Differential Cross Sections for Fixed Values of $q^2$ and $t$ . . . . .	119
6.2.4. Separation of $d\sigma_w/dt$ and $d\sigma_I/dt$ . . . . .	120
6.3. Electroproduction of $\pi^+$ -Mesons together with an Additional Excitation of the $\Delta(1236)$ Nucleon Resonance [28, 29] . . . . .	123
6.4. Electroproduction of $K^+$ -Mesons [31] According to the Reaction . . . . .	125
6.5. Electroproduction of $\varrho^0$ -Mesons on Protons [32] . . . . .	126
6.6. Electroproduction of $\pi^0$ -Mesons in the Backward Direction [36, 37] . . . . .	128
6.7. Electroproduction of Vector Mesons in the Backward Direction [39, 40] . . . . .	128
7. Discussion of the Data on Electroproduction of Mesons under the Aspect of Models of Production Dynamics . . . . .	130
7.1. The Born Model . . . . .	130
7.2. The Vector Meson Dominance Model [46] . . . . .	133

8. Combined Consideration of the Experimental Data and the Corresponding Models of the Total and Differential Cross Sections of Virtual-Photon Production Processes	138
8.1. Review of the Essential Experimental Data . . . . .	138
8.2. Meson-Production and Excitation of Nucleon Resonances . . . . .	138
8.3. Longitudinal Cross Sections and Vector Meson Dominance . . . . .	138
8.4. Diffraction in the Deep Inelastic Region . . . . .	141
8.5. A Glance at the Parton Model . . . . .	141
References . . . . .	142