

# Contents

<b>1</b>	<b>Introduction</b>	1
<b>2</b>	<b>Algebraic Approach to Quantum Theory</b>	3
2.1	Algebraic Quantum Mechanics	3
2.1.1	Functional Analytic Preliminaries	3
2.1.2	Observables and States	6
2.1.3	Hilbert Space Representations	8
2.1.4	Dynamics and the Interaction Picture	15
2.2	Causality	17
2.3	Haag–Kastler Axioms	21
2.4	pAQFT Axioms	23
2.4.1	More Functional Analysis	24
2.4.2	Axioms	26
2.5	Locally Covariant Quantum Field Theory	27
	References	34
<b>3</b>	<b>Kinematical Structure</b>	39
3.1	The Space of Field Configurations	39
3.2	Functionals on the Configuration Space	40
3.3	Fermionic Field Configurations	46
3.4	Vector Fields	52
3.5	Functorial Interpretation	55
	References	57
<b>4</b>	<b>Classical Theory</b>	59
4.1	Dynamics	59
4.2	Natural Lagrangians	63
4.3	Homological Characterization of the Solution Space	64
4.4	The Net of Topological Poisson Algebras	67
4.4.1	The Peierls Bracket and Microcausal Functionals	67
4.4.2	Topologies on the Space of Microcausal Functionals	69

4.4.3	The Classical Causal Net . . . . .	73
4.5	Analogy with Classical Mechanics . . . . .	74
4.6	Classical Møller Maps Off-Shell . . . . .	77
	References . . . . .	80
<b>5</b>	<b>Deformation Quantization . . . . .</b>	<b>83</b>
5.1	Star Products . . . . .	83
5.2	The Star Product on the Space of Multivector Fields . . . . .	90
5.3	Kähler Structure . . . . .	92
	References . . . . .	93
<b>6</b>	<b>Interaction and Renormalization of the Scalar Field Theory . . . . .</b>	<b>95</b>
6.1	Outline of the Approach . . . . .	95
6.2	Scattering Matrix and Time Ordered Products . . . . .	96
6.2.1	Wick Products . . . . .	97
6.2.2	Locally Covariant Wick Products . . . . .	98
6.2.3	Time-Ordered Products . . . . .	101
6.2.4	The Formal S-Matrix and Møller Operators . . . . .	103
6.2.5	Epstein–Glaser Axioms . . . . .	110
6.3	Renormalization Group . . . . .	113
6.4	Interacting Local Nets . . . . .	116
6.5	Construction of Time-Ordered Products . . . . .	120
6.5.1	Existence of Time-Ordered Products (Abstract Proof). . . . .	121
6.5.2	Explicit Construction and Feynman Graphs . . . . .	129
6.5.3	Regularization of Distributions . . . . .	133
	References . . . . .	135
<b>7</b>	<b>Gauge Theories . . . . .</b>	<b>137</b>
7.1	Classical Gauge Theory . . . . .	137
7.1.1	Dynamics and Symmetries . . . . .	138
7.1.2	The Koszul–Tate Complex . . . . .	139
7.1.3	The Chevalley–Eilenberg Complex . . . . .	140
7.1.4	The BV Complex . . . . .	142
7.2	Gauge-Fixing . . . . .	145
7.3	Quantization in the Batalin–Vilkoviski Formalism . . . . .	151
	References . . . . .	155
<b>8</b>	<b>Effective Quantum Gravity . . . . .</b>	<b>157</b>
8.1	From LCQFT to Quantum Gravity . . . . .	157
8.2	Dynamics and Symmetries . . . . .	159
8.3	Linearized Theory . . . . .	162
8.4	Quantization . . . . .	164

Contents	xi
8.5 Relational Observables . . . . .	165
8.6 Background Independence . . . . .	167
References . . . . .	170
<b>Glossary</b> . . . . .	173
<b>Index</b> . . . . .	177

Perturbative Algebraic Quantum Field Theory

An Introduction for Mathematicians

Rejzner, K.

2016, XI, 180 p. 4 illus., Hardcover

ISBN: 978-3-319-25899-7