

Cambridge University Press

978-0-521-45692-0 - Diagrammatica: The Path to Feynman Rules

Martinus Veltman

Table of Contents

[More information](#)

## Contents

	<i>Introduction</i>	<i>page xi</i>
<b>1</b>	<b>Lorentz and Poincaré Invariance</b>	<b>1</b>
1.1	Lorentz Invariance	1
1.2	Structure of the Lorentz Group	7
1.3	Poincaré Invariance	10
1.4	Maxwell Equations	10
1.5	Notations and Conventions	12
<b>2</b>	<b>Relativistic Quantum Mechanics of Free Particles</b>	<b>15</b>
2.1	Hilbert Space	15
2.2	Matrices in Hilbert Space	22
2.3	Fields	25
2.4	Structure of Hilbert Space	29
<b>3</b>	<b>Interacting Fields</b>	<b>32</b>
3.1	Physical System	32
3.2	Hilbert Space	33
3.3	Magnitude of Hilbert Space	34
3.4	<i>U</i> -matrix, <i>S</i> -matrix	35
3.5	Interpolating Fields	39
3.6	Feynman Rules	46
3.7	Feynman Propagator	54
3.8	Scattering Cross Section	55
3.9	Lifetime	60
3.10	Numerical Evaluation	62
3.11	Schrödinger Equation, Bound States	62
<b>4</b>	<b>Particles with Spin</b>	<b>68</b>
4.1	Representations of the Lorentz Group	68
4.2	The Dirac Equation	76

viii	<i>Contents</i>	
4.3	Fermion Fields	79
4.4	The E.M. Field	85
4.5	Quantum Electrodynamics	87
4.6	Charged Vector Boson Fields	91
4.7	Electron-Proton Scattering. The Rutherford Formula	92
<b>5</b>	<b>Explorations</b>	<b>98</b>
5.1	Scattering Cross Section for $e^+e^- \rightarrow \mu^+\mu^-$	98
5.2	Pion Decay. Two Body Phase Space. Cabibbo Angle	101
5.3	Vector Boson Decay	105
5.4	Muon Decay. Fiertz Transformation	108
5.5	Hyperon Leptonic Decay	117
5.6	Pion Decay and PCAC	124
5.7	Neutral Pion Decay and PCAC	131
<b>6</b>	<b>Renormalization</b>	<b>137</b>
6.1	Introduction	137
6.2	Loop Integrals	137
6.3	Self Energy	145
6.4	Power Counting	148
6.5	Quantum Electrodynamics	151
6.6	Renormalizable Theories	153
6.7	Radiative Corrections: Lamb Shift	154
6.8	Radiative Corrections: Top Correction to $\rho$ -Parameter	157
6.9	Neutral Pion Decay and the Anomaly	162
<b>7</b>	<b>Massive and Massless Vector Fields</b>	<b>169</b>
7.1	Subsidiary Condition Massive Vector Fields	169
7.2	Subsidiary Condition Massless Vector Fields	171
7.3	Photon Helicities	173
7.4	Propagator and Polarization Vectors of Massive Vector Particles	174
7.5	Photon Propagator	177
7.6	Left Handed Photons	180
<b>8</b>	<b>Unitarity</b>	<b>183</b>
8.1	$U$ -matrix	183
8.2	Largest Time Equation	185
8.3	Cutting Equations	187
8.4	Unitarity and Cutting Equation	191
8.5	Unitarity: General Case	197

Cambridge University Press

978-0-521-45692-0 - Diagrammatica: The Path to Feynman Rules

Martinus Veltman

Table of Contents

[More information](#)

<i>Contents</i>		ix
8.6	Källén–Lehmann Representation, Dispersion Relation	200
8.7	Momenta in Propagators	204
<b>9</b>	<b>Quantum Electrodynamics: Finally</b>	<b>207</b>
9.1	Unitarity	207
9.2	Ward Identities	208
<b>Appendix A Complex Spaces, Matrices, CBH Equation</b>		<b>213</b>
A.1	Basics	213
A.2	Differentiation of Matrices	217
A.3	Functions of Matrices	218
A.4	The CBH Equation	220
<b>Appendix B Traces</b>		<b>224</b>
B.1	General	224
B.2	Multi-Dimensional $\gamma$ -Matrices	230
B.3	Frequently Used Equations	231
<b>Appendix C Dimensional Regularization</b>		<b>233</b>
<b>Appendix D Summary. Combinatorial Factors</b>		<b>243</b>
D.1	Summary	243
D.2	External Lines, Spin Sums, Propagators	245
D.3	Combinatorial Factors	247
<b>Appendix E Standard Model</b>		<b>249</b>
E.1	Lagrangian	249
E.2	Feynman Rules	258
<b>Appendix F Metric and Conventions</b>		<b>273</b>
F.1	General Considerations	273
F.2	Translation Examples	279
F.3	Translation Dictionary	281
	<i>Index</i>	282