

Contents

1	Introduction	1
	References	4
2	The Standard Model and Its Supersymmetric Extensions	7
2.1	The Standard Model	7
2.1.1	Symmetries	8
2.1.2	Electroweak Theory and the BEH Mechanism in the SM	9
2.1.3	Fermion Sector	10
2.1.4	Gauge Fixing, Ghost Sector	11
2.1.5	Full SM Lagrangian	12
2.1.6	Shortcomings of the SM	12
2.2	The Minimal Supersymmetric Standard Model	14
2.2.1	Concepts of Supersymmetric Models	14
2.2.2	The MSSM Superpotential	17
2.2.3	R-Parity	18
2.2.4	SUSY Breaking	19
2.2.5	Constrained Models: CMSSM and pMSSM	19
2.2.6	Sfermion Sector	20
2.2.7	Chargino Sector	22
2.2.8	Neutralino Sector	22
2.2.9	Gluino Sector	23
2.2.10	Electroweak Symmetry Breaking and the MSSM Higgs Sector	23
2.3	The Next to Minimal Supersymmetric Standard Model	26
2.3.1	Motivation	27
2.3.2	The NMSSM Superpotential and Soft Breaking Terms	27
2.3.3	Higgs Sector of the NMSSM	28

2.3.4	Neutralino Sector of the NMSSM	29
2.3.5	MSSM and Decoupling Limit.	30
	References	30
3	Perturbative Calculations	33
3.1	Introduction	33
3.2	The Concepts of Regularization and Renormalization.	33
3.2.1	On-Shell Renormalization Scheme	35
3.2.2	Self-Energies	36
3.2.3	\overline{MS} Renormalization Scheme, Renormalization Group Equations and Implications for QCD.	37
	References	38
4	Experimental Status	41
4.1	Collider Experiments	41
4.2	Experimental Results	43
4.2.1	Discovery of a Higgs Boson	43
4.2.2	Searches for SUSY Higgs Bosons.	46
4.2.3	Direct SUSY Searches.	47
4.2.4	Precision Measurements: M_W and m_t	49
4.2.5	B -Physics Observables and $(g - 2)_\mu$	50
	References	50
5	The W Boson Mass in the SM, the MSSM and the NMSSM	53
5.1	Introduction	53
5.2	Determination of the W Boson Mass	55
5.3	Calculation of Δr	56
5.3.1	One-Loop Formula for Δr	57
5.3.2	One-Loop Δr in the SM	58
5.3.3	One-Loop Δr in the MSSM and the NMSSM	59
5.3.4	Incorporation of Higher-Order Corrections to Δr	62
5.4	Technical Aspects	67
5.4.1	Framework for the Δr Calculation	67
5.4.2	Framework for the Numerical Analysis	68
5.4.3	Constraints on the Parameter Space.	69
5.4.4	<code>FeynArts</code> Model File for the NMSSM	71
5.5	Theoretical Uncertainties in the M_W Prediction	72
5.6	Result for M_W in the SM	73
5.7	Result for M_W in the MSSM.	75
5.7.1	MSSM Parameter Scan: Scan Ranges and Constraints.	75
5.7.2	Results of the Scan and Impact of LHC Results on M_W in the MSSM	76

5.7.3	Discussion of Future Scenarios	84
5.7.4	Dependence of the M_W Prediction on Complex Phases	87
5.8	Results for the M_W Prediction in the NMSSM	90
5.8.1	Sfermion Sector One-Loop Contributions	90
5.8.2	Effect of SUSY Two-Loop Corrections	95
5.8.3	NMSSM Higgs Sector Contributions	99
5.8.4	Neutralino Sector Contributions	105
5.9	Summary	110
	References	113
6	The Diphoton Decay Channel in the MSSM and the NMSSM	119
6.1	Introduction	119
6.2	Framework of Our Analysis	120
6.2.1	General Considerations	120
6.2.2	Calculational Framework	122
6.2.3	Constraints on the Parameter Space	122
6.3	Numerical Analysis	124
6.3.1	Decays of CP -Even Higgs Bosons in the MSSM	125
6.3.2	Decays of CP -Even Higgs Bosons in the NMSSM	130
6.4	Summary	135
	References	137
7	Fitting the MSSM to the Observed Higgs Signal	141
7.1	Motivation	141
7.2	Framework for Our Analysis	142
7.2.1	pMSSM Parameter Scans	142
7.2.2	Constraints on the Parameter Space	144
7.2.3	χ^2 Fits	145
7.3	Results	149
7.4	Summary	171
	References	173
8	Constraining SUSY Scenarios Using Simplified Models	179
8.1	Introduction	179
8.2	Methodology	180
8.2.1	The Traditional “Recasting” Approach	180
8.2.2	A New Approach to Calculate the Visible Cross Section	181
8.3	Functionality of the Program Fastlim	183
8.3.1	The Calculational Procedure	183
8.3.2	Nomenclature of the Event Topologies	184
8.3.3	Further Approximations	185
8.4	Fastlim Version 1.0	187
8.4.1	The Available Analyses	187
8.4.2	The Implemented Event Topologies	188

8.5	Constraints from Direct Searches on “Natural” SUSY Models. . . .	189
8.6	Summary and Future Plans.	197
	References	198
9	Conclusions	201
	References	204

Constraining Supersymmetric Models
Using Higgs Physics, Precision Observables and Direct
Searches

Zeune, L.

2016, XVI, 205 p., Hardcover

ISBN: 978-3-319-22227-1