

Contents

1	Electromagnetic Duality and Monopoles	1
1.1	Electric and Magnetic Charges	1
1.2	The S and the T Transformations	4
1.3	't Hooft-Polyakov Monopoles	7
1.3.1	Classical Features	7
1.3.2	Semiclassical Features	9
	References	11
2	$\mathcal{N}=2$ Multiplets and Lagrangians	13
2.1	Microscopic Lagrangian	13
2.1.1	$\mathcal{N}=1$ Superfields	13
2.1.2	Vector Multiplets and Hypermultiplets	15
2.2	Vacua	17
2.3	BPS Bound	20
2.4	Low Energy Lagrangian	21
	References	24
3	Renormalization and Anomaly	25
3.1	Renormalization	25
3.2	Anomalies	28
3.2.1	Anomalies of Global Symmetry	28
3.2.2	Anomalies of Gauge Symmetry	30
3.3	$\mathcal{N}=1$ Pure Yang–Mills	31
3.3.1	Confinement and Gaugino Condensate	31
3.3.2	The Theory in a Box	32
	References	35
4	Seiberg–Witten Solution to Pure SU(2) Theory	37
4.1	One-Loop Running and the Monodromy at Infinity	37
4.2	Behavior in the Strongly-Coupled Region	40

4.3	The Seiberg–Witten Solution	43
4.3.1	The Curve	43
4.3.2	The Monodromy M_∞	45
4.3.3	The Monodromies M_\pm	47
4.4	Less Supersymmetric Cases	49
4.4.1	$\mathcal{N}=1$ System	49
4.4.2	Pure Bosonic System	51
4.5	SU(2) vs SO(3)	52
	References	54
5	SU(2) Theory with One Flavor	55
5.1	Structure of the u -Plane	55
5.1.1	Schematic Running of the Coupling	55
5.1.2	Monodromies	58
5.2	The Curve	59
5.3	Some Notable Features	63
	References	64
6	Curves and 6d $\mathcal{N}=(2, 0)$ Theory	65
6.1	Strings with Variable Tension	65
6.2	Strings with Variable Tension from Membranes	67
6.2.1	General Idea	67
6.2.2	Example: Pure SU(2) Theory	69
6.3	Self-duality of the 6d Theory	71
6.4	Intermediate 5d Yang–Mills Theory and Its Boundary Conditions	73
6.4.1	Five-Dimensional Maximally-Supersymmetric Yang–Mills	73
6.4.2	$\mathcal{N}=4$ Super Yang–Mills	74
6.4.3	$\mathcal{N}=2$ Pure SU(2) Theory and the $N_f = 1$ Theory	75
6.4.4	The SU(2) Theories with $N_f = 2, 3, 4$	76
	References	79
7	Higgs Branches and Hyperkähler Manifolds	81
7.1	General Structures of the Higgs Branch Lagrangian	81
7.2	Hypermultiplets Revisited	83
7.3	The Hyperkähler Quotient	85
7.3.1	U(1) Gauge Theory with One Charged Hypermultiplet	86
7.3.2	SU(2) Gauge Theory with Two Hypermultiplets in the Doublet	88
	Reference	90
8	SU(2) Theory with 2 and 3 Flavors	91
8.1	Generalities	91
8.2	$N_f = 2$: The Curve and the Monodromies	92
8.3	$N_f = 2$: The Discrete R-Symmetry	96

8.4	$N_f = 2$: The Moduli Space	98
8.5	$N_f = 3$	100
	Reference	103
9	SU(2) Theory with Four Flavors and Gaiotto's Duality	105
9.1	The Curve as $\lambda^2 = \phi_2(z)$	105
9.2	Identification of Parameters	108
9.2.1	Coupling Constant	108
9.2.2	Mass Parameters	110
9.3	Weak-Coupling Limit and Trifundamentals	111
9.4	Strong-Coupling Limit	113
9.5	Generalization	117
9.5.1	Trivalent Diagrams	117
9.5.2	Example: Torus with One Puncture	118
9.5.3	Example: Sphere with Five Punctures	120
9.5.4	Example: A Genus-Two Surface	121
9.5.5	The Curve and the Hitchin Field	123
9.6	Theories with Less Flavors Revisited	124
9.6.1	Rewriting of the Curves	124
9.6.2	Generalization	126
	References	127
10	Argyres–Douglas CFTs	129
10.1	$N_f = 1$ Theory and the Simplest Argyres–Douglas CFT	129
10.2	Argyres–Douglas CFT from the $N_f = 2$ Theory	133
10.3	Argyres–Douglas CFT from the $N_f = 3$ Theory	135
10.4	Summary of Rank-1 Theories	137
10.4.1	Argyres–Douglas CFTs from SU(2) with Flavors	137
10.4.2	Exceptional Theories of Minahan–Nemeschansky	138
10.4.3	Newer Rank-1 Theories	140
10.5	More General Argyres–Douglas CFTs: X_N and Y_N	140
	References	144
11	Theories with Other Simple Gauge Groups	145
11.1	Semiclassical Analysis	145
11.2	Pure SU(N) Theory	147
11.2.1	The Curve	147
11.2.2	Infrared Gauge Coupling Matrix	150
11.3	SU(N) Theory with Fundamental Flavors	152
11.3.1	$N_f = 1$	152
11.3.2	General Number of Flavors	153
11.4	SO($2N$) Theories	156
11.4.1	Semi-classical Analysis	156
11.4.2	Pure SO($2N$) Theory	157
11.4.3	SO($2N$) Theory with Flavors in the Vector Representation	159

11.5	Argyres–Douglas CFTs	161
11.5.1	Pure $SU(N)$ Theory	161
11.5.2	$SU(N)$ Theory with Two Flavors	162
11.5.3	Pure $SO(2N)$ Theory	163
11.5.4	Argyres–Douglas CFTs and the Higgs Branch	164
11.6	Seiberg–Witten Solutions for Various Other Simple Gauge Groups	165
	References	167
12	Argyres–Seiberg–Gaiotto Duality for $SU(N)$ Theory	169
12.1	S-Dual of $SU(N)$ with $N_f = 2N$ Flavors, Part I	169
12.1.1	Rewriting of the Curve	169
12.1.2	Weak-Coupling Limit	172
12.1.3	A Strong-Coupling Limit	172
12.2	$SU(N)$ Quiver Theories and Tame Punctures	173
12.2.1	Quiver Gauge Theories	173
12.2.2	$\mathcal{N}=2^*$ Theory	175
12.2.3	Linear Quiver Theories	175
12.2.4	Tame Punctures	177
12.2.5	Tame Punctures and the Number of Coulomb Branch Operators	180
12.2.6	Tame Punctures and the Decoupling	181
12.3	S-Dual of $SU(N)$ with $N_f = 2N$ Flavors, Part II	183
12.3.1	For General N	183
12.3.2	$N = 3$: Argyres–Seiberg Duality	184
12.4	Applications	187
12.4.1	T_N	187
12.4.2	$MN(E_7)$	188
12.4.3	$MN(E_8)$	190
12.4.4	The Singular Limit of $SU(N)$ with Even Number of Flavors	191
12.5	Tame Punctures and Higgsing	193
	References	199
13	Conclusions and Further Directions	201
	References	204
A	Prepotential and the Instanton Computation	207
A.1	Prepotential from the Curve	207
A.2	Prepotential from the Instanton Computation	209
A.2.1	The Ω Background	209
A.2.2	Reduction to Supersymmetric Quantum Mechanics	211
A.2.3	Concrete Computations	212
	References	216

B	The Zoo of $\mathcal{N}=2$ Theories	217
B.1	Gauge Theories	217
B.2	6d Constructions	218
B.2.1	Types of 6d $\mathcal{N}=(2, 0)$ Theories	218
B.2.2	Punctures of the 6d Theory.....	219
B.2.3	Basic Building Blocks.....	219
B.3	Other Stringy Constructions	221
B.3.1	F-Theoretic Construction.....	221
B.3.2	Type IIB on a Singular Calabi-Yau	222
	References.....	224

N=2 Supersymmetric Dynamics for Pedestrians

Tachikawa, Y.

2015, XVIII, 224 p. 122 illus., Softcover

ISBN: 978-3-319-08821-1