

Contents

Title	ii
Abstract	iii
Acknowledgements	iv
Contents	vii
Introduction	1
Overview	7

I $\text{AdS}_3/\text{CFT}_2$ higher-spin dualities 9

1 CFT Toolbox	11
1.1 Conformal field theory in two dimensions	11
1.2 Superconformal field theories	19
1.3 Affine Kač-Moody algebras	26
1.4 GKO coset construction	35
2 Higher-Spin holography	41
2.1 Review of higher-spin theory in AdS_3	41
2.2 Review of higher-spin holography	45
2.3 $\mathcal{N} = 4$ holographic duality	51
3 Even-spin $\mathcal{N} = 4$ holography	55
3.1 $\text{Sp}(2N)$ vector model	55
3.2 Coset generalisation	57
3.3 Higher-spin dual	58

II From higher-spins to strings: view from holography 61

4 String theory in $\text{AdS}_3 \times \text{S}^3$	63
4.1 Basic notions of string theory	63
4.2 D1-D5 system and AdS/CFT correspondence	67
5 Higher-spins at the symmetric orbifold point	73
5.1 Relating the holographic CFT's	74
5.2 Twisted and untwisted sectors	75
5.3 Higher-spin square	76

5.4	Even-spin construction	79
III	From strings to higher-spins: worldsheet viewpoint	87
6	RNS strings in $\text{AdS}_3 \times \text{S}^3$	89
6.1	Worldsheet CFT	89
6.2	Representations of $\mathfrak{sl}(2, \mathbb{R})$	90
6.3	Short strings	92
6.4	Spectrally flowed sectors and long strings	99
6.5	BPS spectrum at finite k	101
6.6	Minimal long strings	102
7	Higher-spins in the RNS formalism	105
7.1	Looking for massless states	105
7.2	Massless states for $k = 1$	107
7.3	Regge trajectories	107
8	Beyond the WZW-point: the hybrid formalism	119
8.1	Review of the hybrid formalism	119
8.2	Semiclassical analysis	121
8.3	Review of the current algebra	123
8.4	Representations	126
8.5	Conformal weights of single-sided excitations	128
8.6	Large charge limit	130
8.7	BMN limit	132
9	First results from the hybrid formalism	135
9.1	Reproducing the BMN formula	135
9.2	$\text{AdS}_3 \times \text{S}^3 \times \text{S}^3 \times \text{S}^1$	137
9.3	Continuous representations	138
9.4	Missing chiral primaries	139
IV	Conclusions	143
10	Conclusions and outlook	145
10.1	Summary and conclusions	145
10.2	Outlook	147
	Appendices	149
A	Important results for even-spin $\mathcal{N} = 4$ holography	151
A.1	Chiral algebra of the vector model	151
A.2	The coset model	153
A.3	Matching one-loop partition functions	160
B	Proof of the R-sector no-ghost theorem	165

C	Properties of Lie superalgebras	169
C.1	Root system and classification	169
C.2	The (affine) Lie superalgebra $\mathfrak{psu}(1, 1 2)$	169
C.3	The (affine) Lie superalgebra $\mathcal{D}(2, 1; \alpha)$	170
	Bibliography	183