

# CONTENTS

Preface . . . . .		v
Introductory Chapters . . . . .		xi
<b>1. History and background</b>		
1.1 I.M. Gel'fand and L.A. Dickij, <i>A family of hamiltonian structures related to non-linear integrable differential equations</i> , Prepr. Inst. Appl. Mat. <b>136</b> (Moscow, 1978), reprinted in 'I.M. Gel'fand, Collected Papers', Vol. 1, S.G. Gindikin <i>et al.</i> editors (Springer-Verlag, 1987), pp. 625–646 . . . . .		3
1.2 V. Drinfel'd and V. Sokolov, <i>Lie algebras and equations of Korteweg-de Vries type</i> , J. Sov. Math. <b>30</b> (1984) 1975–2036 . . . . .		25
<b>2. Classical <math>\mathcal{W}</math>-algebras and their connection to Toda field theories</b>		
2.1 A. Bilal and J.-L. Gervais, <i>Systematic approach to conformal systems with extended Virasoro symmetries</i> , Phys. Lett. <b>206B</b> (1988) 412–420 . . . . .		89
2.2 I. Bakas, <i>Higher spin fields and the Gel'fand-Dickey algebra</i> , Comm. Math. Phys. <b>123</b> (1989) 627–639. . . . .		98
2.3 J. Balog, L. Fehér, L. O'Raiheartaigh, P. Forgács and A. Wipf, <i>Toda theory and <math>\mathcal{W}</math>-algebra from a gauged WZNW point of view</i> , Ann. Phys. <b>203</b> (1990) 76–136 . . . . .		111
2.4 F. A. Bais, T. Tjin and P. van Driel, <i>Covariantly coupled chiral algebras</i> , Nucl. Phys. <b>B357</b> (1991) 632–654 . . . . .		172
2.5 F. Delduc, E. Ragoucy and P. Sorba, <i>Super-Toda theories and <math>\mathcal{W}</math>-algebras from superspace Wess-Zumino-Witten models</i> , Comm. Phys. <b>146</b> (1992) 403–426 . . . . .		195
<b>3. Quantum <math>\mathcal{W}</math>-algebras</b>		
3.1 A. B. Zamoldchikov, <i>Infinite additional symmetries in two dimensional conformal quantum field theory</i> , Theor. Math. Phys. <b>65</b> (1985) 1205–1213 . . . . .		221
3.2 P. Bouwknegt, <i>Extended conformal algebras</i> , Phys. Lett. <b>207B</b> (1988) 295–299 . . . . .		230

- 3.3 R. Blumenhagen, M. Flohr, A. Kliem, W. Nahm, A. Recknagel and R. Varnhagen,  *$\mathcal{W}$ -algebras with two and three generators*, Nucl. Phys. **B361** (1991) 255–289 . . . . . 235
- 3.4 J. de Boer, L. Féher and A. Honecker, *A class of  $\mathcal{W}$ -algebras with infinitely generated classical limit*, ITP-SB-93-84, BONN-HE-93-49, submitted to Nucl. Phys. B, 38 pages . . . . . 270

#### 4. Quantum Drinfel'd-Sokolov reduction

- 4.1 V. A. Fateev and S. L. Lukyanov, *The models of two dimensional conformal quantum field theory with  $Z_n$  symmetry*, Int. Jour. Mod. Phys. **A3** (1988) 507–520 . . . . . 311
- 4.2 V. A. Fateev and S. L. Lukyanov, *Exactly soluble models of conformal quantum field theory associated with the simple Lie algebra  $D_n$* , Sov. J. Nuc. Phys. **49** (1989) 925–932 . . . . . 325
- 4.3 M. Bershadsky and H. Ooguri, *Hidden  $SL(n)$  symmetry in conformal field theories*, Comm. Math. Phys. **126** (1989) 49–83 . . . . . 333
- 4.4 J. M. Figueroa-O'Farrill, *On the homological construction of Casimir algebras*, Nucl. Phys. **B343** (1990) 450–466 . . . . . 368
- 4.5 E. Frenkel,  *$\mathcal{W}$ -algebras and Langlands-Drinfeld correspondence*, in Proc. of the 1991 Cargèse Summer School 'New Symmetry Principles in Quantum Field Theory', eds. J. Fröhlich et al. (Plenum Press, New York, 1992), 433–447 . . . . . 385
- 4.6 E. Frenkel, V. Kac and M. Wakimoto, *Characters and fusion rules for  $\mathcal{W}$ -algebras via quantized Drinfeld-Sokolov reduction*, Comm. Math. Phys. **147** (1992) 295–328 . . . . . 400
- 4.7 P. Bowcock and G. M. T. Watts, *On the classification of quantum  $\mathcal{W}$ -algebras*, Nucl. Phys. **B379** (1992) 63–95 . . . . . 434
- 4.8 J. de Boer and T. Tjin, *The relation between quantum  $\mathcal{W}$ -algebras and Lie algebras*, Comm. Math. Phys. **160** (1994) 317–332 . . . . . 467
- 4.9 A. Sevrin and W. Troost, *Extensions of the Virasoro algebra and gauged WZW models*, Phys. Lett. **315B** (1993) 304–310 . . . . . 483

#### 5. Coset constructions

- 5.1 F. A. Bais, P. Bouwknegt, K. Schoutens and M. Surridge, *Extensions of the Virasoro algebra constructed from Kac-Moody algebras using higher order Casimir invariants*, Nucl. Phys. **B304** (1988) 348–370 . . . . . 493

- 
- 5.2 F. A. Bais, P. Bouwknegt, K. Schoutens and M. Surridge,  
*Coset construction for extended Virasoro algebras*,  
Nucl. Phys. **B304** (1988) 371–391 . . . . . 516
- 5.3 P. Bowcock and P. Goddard, *Coset constructions and extended  
conformal algebras*, Nucl. Phys. **B305**[FS23] (1988) 685–709 . . . 537
- 5.4 G. M. T. Watts,  *$\mathcal{W}$ -algebras and coset models*,  
Phys. Lett. **245B** (1990) 65–71 . . . . . 562
- 6.  $\mathcal{W}_\infty$  type algebras**
- 6.1 I. Bakas, *The large- $N$  limit of extended conformal symmetries*,  
Phys. Lett. **228B** (1989) 57–63 . . . . . 571
- 6.2 C. N. Pope, L. J. Romans and X. Shen,  *$\mathcal{W}_\infty$  and the Racah-Wigner  
algebra*, Nucl. Phys. **B339** (1990) 191–221 . . . . . 578
- 6.3 C. N. Pope, L. J. Romans and X. Shen, *A new higher-spin  
algebra and the lone-star product*, Phys. Lett. **242B** (1990) 401–406 609
- 6.4 I. Bakas and E. Kiritsis, *Beyond the large- $N$  limit: non-linear  
 $\mathcal{W}_\infty$  as symmetry of the  $SL(2, \mathbb{R}/U(1)$  coset model*,  
Int. Jour. Mod. Phys. **A7**[Suppl. 1A] (1992) 55–81 . . . . . 615
- 6.5 J. Figueroa-O’Farrill, J. Mas and E. Ramos, *The topography of  
 $\mathcal{W}_\infty$ -type algebras*, Phys. Lett. **299B** (1993) 41–48 . . . . . 642
- 7.  $\mathcal{W}$ -gravity and  $\mathcal{W}$ -strings**
- 7.1 J. Thierry-Mieg, *BRS-analysis of Zamolodchikov’s spin 2 and  
 $\mathfrak{g}$  current algebra*, Phys. Lett. **197B** (1987) 368–372 . . . . . 659
- 7.2 C. M. Hull, *Gauging the Zamolodchikov  $\mathcal{W}$ -algebra*, Phys. Lett.  
**240B** (1990) 110–116 . . . . . 664
- 7.3 K. Schoutens, A. Sevrin and P. van Nieuwenhuizen,  
*Properties of covariant  $\mathcal{W}$ -gravity*, Int. Journ. Mod. Phys.  
**A6** (1991) 2891–2912 . . . . . 671
- 7.4 S. R. Das, A. Dhar and S. K. Rama, *Physical properties of  
 $\mathcal{W}$ -gravities and  $\mathcal{W}$ -strings*, Mod. Phys. Lett. **A6**  
(1991) 3055–3069 . . . . . 693
- 7.5 K. Schoutens, A. Sevrin and P. van Nieuwenhuizen, *Induced gauge  
theories and  $\mathcal{W}$ -gravity*, in Proc. of the conference  
‘Strings and Symmetries 1991’, Stony Brook, May 1991,  
N. Berkovits *et al.* (World Scientific, 1992), pages 558–590 . . . . 708
- 7.6 J. de Boer and J. Goeree,  *$\mathcal{W}$ -gravity from Chern-Simons theory*,  
Nucl. Phys. **B381** (1992) 329–359 . . . . . 741

7.7	H. Lu, C. N. Pope, S. Schrans and X.-J. Wang, <i>On the spectrum and scattering of <math>\mathcal{W}_3</math> strings</i> , Nucl. Phys. <b>B408</b> (1993) 3–42 . . . . .	772
7.8	M. Bershadsky, W. Lerche, D. Nemeschansky and N. P. Warner, <i>A BRST operator for non-critical <math>\mathcal{W}</math>-strings</i> , Phys. Lett. <b>282B</b> (1992) 35–41 . . . . .	812
7.9	P. Bouwknegt, J. McCarthy and K. Pilch, <i>Semi-infinite cohomology of <math>\mathcal{W}</math>-algebras</i> , Lett. Math. Phys. <b>29</b> (1993) 91–102 . . . . .	826
7.10	H. Lu, C. N. Pope, X. J. Wang and K. W. Xu, <i>The complete cohomology of the <math>\mathcal{W}_3</math> string</i> , Class. Quant. Grav. <b>11</b> (1994) 967–982 . . . . .	838
	References . . . . .	857