Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

References

[Abe80] E. Abe, *Hopf algebras*, Cambridge University Press, Cambridge, 1980.

[AT86] A. Achúcarro and P. K. Townsend, *A Chern-Simons action for three-dimensional anti-de Sitter supergravity theories*, Phys. Lett. **B 180** (1986), 89–92.

[AT89] A. Achúcarro and P. K. Townsend, *Extended supergravities in $d = 2+1$ as Chern-Simons theories*, Phys. Lett. **B 229** (1989), 383–387.

[Ash86] A. Ashtekar, *New Variables for Classical and Quantum Gravity*, Phys. Rev. Lett. **57** (1986), 2244–2247.

[Ati89] M. Atiyah, *Topological quantum field theories*, Inst. Hautes Études Sci. Publ. Math. (1989), no. 68, 175–186.

[Bae98] J. C. Baez, *Spin foam models*, Class. Quantum Grav. **15** (1998), 1827–1858, gr-qc/9709052.

[Bae00] J. C. Baez, *An Introduction to Spin Foam Models of BF Theory and Quantum Gravity*, Geometry and quantum physics (Schladming, 1999), Lecture Notes in Phys., no. 543, Springer, Berlin, 2000, pp. 25–93, gr-qc/9905087.

[BK01] B. Bakalov and A. Kirillov, *Lectures on Tensor Categories and Modular Functors*, American Mathematical Society, Providence, 2001.

[BC98] J. W. Barrett and L. Crane, *Relativistic spin networks and quantum gravity*, J. Math. Phys. **39** (1998), 3296–3302, gr-qc/9709028.

[BW96] J. W. Barrett and B. W. Westbury, *Invariants of piecewise-linear 3-manifolds*, Trans. Amer. Math. Soc. **348** (1996), 3997–4022, hep-th/9311155.

[BW99] J. W. Barrett and B. W. Westbury, *Spherical categories*, Adv. Math. **143** (1999), 357–375, hep-th/9310164.

[Bou92] D. V. Boulatov, *A model of three-dimensional lattice gravity*, Mod. Phys. Lett. **A 7** (1992), 1629–1646, hep-th/9202074.

[CSM95] R. Carter, G. Segal, and I. MacDonald, *Lectures on Lie Groups and Lie Algebras*, Cambridge University Press, Cambridge, 1995.

[CP94] V. Chari and A. Pressley, *A guide to Quantum Groups*, Cambridge University Press, Cambridge, 1994.

[Col84] J. Collins, *Renormalization*, Cambridge University Press, Cambridge, 1984.

[Cra01] L. Crane, *A New Approach to the Geometrization of Matter*, Preprint gr-qc/0110060, 2001.

[CKY93] L. Crane, L. H. Kauffman, and D. N. Yetter, *Evaluating the Crane-Yetter invariant*, Quantum topology, Ser. Knots Everything, no. 3, World Scientific, River Edge, NJ, 1993, pp. 131–138, hep-th/9309063.

[CKY97] L. Crane, L. H. Kauffman, and D. N. Yetter, *State-Sum Invariants of 4-Manifolds*, J. Knot Theory Ram. **6** (1997), 177–234, hep-th/9409167.

[CY93] L. Crane and D. Yetter, *A categorical construction of 4d topological quantum field theory*, Quantum Topology (Dayton, 1992), Series on Knots and Everything, vol. 3, World Scientific, Singapore, 1993, pp. 120–130, hep-th/9301062.

[Cre83] M. Creutz, *Quarks, gluons and lattices*, Cambridge University Press, Cambridge, 1983.

[Dav85] F. David, *Planar diagrams, two-dimensional lattice gravity and surface models*, Nucl. Phys. **B 257** (1985), 45–58.

[DFKR00] R. De Pietri, L. Freidel, K. Krasnov, and C. Rovelli, *Barrett-Crane model from a Boulatov-Ooguri field theory over a homogeneous space*, Nucl. Phys. **B 574** (2000), 785–806, hep-th/9907154.

[Dri87] V. G. Drinfeld, *Quantum Groups*, Proceedings of the ICM 1986 (A. Gleason, ed.), AMS, Rhode Island, 1987, pp. 798–820.

[FRT90] L. D. Faddeev, N. Yu. Reshetikhin, and L. A. Takhtadzhyan, *Quantization of Lie groups and Lie algebras*, Leningrad Math. J. **1** (1990), 193–225.

[FM02] D. Fiorenza and R. Murri, *Feynman Diagrams via Graphical Calculus*, J. Knot Theory Ram. **11** (2002), 1095–1131, math.QA/0106001.

[FKP99] L. Freidel, K. Krasnov, and R. Puzio, *BF Description of Higher-Dimensional Gravity Theories*, Adv. Theor. Math. Phys. **3** (1999), 1289–1324, hep-th/9901069.

[FY89] P. J. Freyd and D. N. Yetter, *Braided Compact Closed Categories with Applications to Low Dimensional Topology*, Adv. Math. **77** (1989), 156–182.

[FP90] R. Fritsch and R. A. Piccinini, *Cellular structures in topology*, Cambridge University Press, Cambridge, 1990.

[GOP02] F. Girelli, R. Oeckl, and A. Perez, *Spin foam diagrammatics and topological invariance*, Class. Quantum Grav. **19** (2002), 1093–1108, gr-qc/0111022.

[ID89] C. Itzykson and J.-M. Drouffe, *Statistical field theory I,II*, Cambridge University Press, Cambridge, 1989.

[Kas95] C. Kassel, *Quantum groups*, Springer, New York, 1995.

[KL94] L. H. Kauffman and S. L. Lins, *Temperly-Lieb Recoupling Theory and Invariants of 3-Manifolds*, Princeton University Press, Princeton, 1994.

[KS97] A. Klimyk and K. Schmüdgen, *Quantum Groups and Their Representations*, Springer, Berlin, 1997.

Discrete Gauge Theory Downloaded from www.worldscientific.com by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

[KW41] H. A. Kramers and G. H. Wannier, *Statistics of the two-dimensional ferromagnet. I*, Phys. Rev. **60** (1941), 252–262.

[LS01] Y. Ling and L. Smolin, *Eleven-dimensional supergravity as a constrained topological field theory*, Nucl. Phys. **B 601** (2001), 191–208, hep-th/0003285.

[LO03] E. R. Livine and R. Oeckl, *Three-dimensional Quantum Supergravity and Supersymmetric Spin Foam Models*, Adv. Theor. Math. Phys. **7** (2003), 951–1001, hep-th/0307251.

[Mac98] S. Mac Lane, *Categories for the Working Mathematician*, 2nd ed., Springer, New York, 1998.

[Maj95] S. Majid, *Foundations of Quantum Group Theory*, Cambridge University Press, Cambridge, 1995.

[Mar03] F. Markopoulou, *Coarse graining in spin foam models*, Class. Quantum Grav. **20** (2003), 777–799, gr-gc/0203036.

[Mau80] C. R. F. Maunder, *Algebraic Topology*, Cambridge University Press, Cambridge, 1980.

[Mig76] A. A. Migdal, *Recursion equations in gauge field theories*, Sov. Phys. JETP **42** (1976), 413–418.

[Moi52] E. E. Moise, *Affine Structures in 3-Manifolds*, Ann. Math. **56** (1952), 96–114.

[MM97] I. Montvay and G. Münster, *Quantum fields on a lattice*, Cambridge University Press, Cambridge, 1997.

[Nak90] M. Nakahara, *Geometry, Topology and Physics*, Institute of Physics, Bristol, 1990.

[NS83] C. Nash and S. Sen, *Topology and geometry for physicists*, Academic Press, London, 1983.

[Oec00] R. Oeckl, *Introduction to Braided Quantum Field Theory*, Int. J. Mod. Phys. **B 14** (2000), 2461–2466.

[Oec01a] R. Oeckl, *Braided Quantum Field Theory*, Commun. Math. Phys. **217** (2001), 451–473, hep-th/9906225.

[Oec01b] R. Oeckl, *The quantum geometry of spin and statistics*, J. Geom. Phys. **39** (2001), 233–252, hep-th/0008072.

[Oec02] R. Oeckl, *The quantum geometry of supersymmetry and the generalized group extension problem*, J. Geom. Phys. **44** (2002), 299–330, hep-th/0106122.

[Oec03a] R. Oeckl, *Generalized lattice gauge theory, spin foams and state sum invariants*, J. Geom. Phys. **46** (2003), 308–354, hep-th/0110259.

[Oec03b] R. Oeckl, *Renormalization of discrete models without background*, Nucl. Phys. **B 657** (2003), 107–138, gr-qc/0212047.

[Oec05] R. Oeckl, *Renormalization for spin foam models of quantum gravity*, Proceedings of the Tenth Marcel Grossmann Meeting on General Relativity (Rio de Janeiro, 2003), World Scientific, Singapore, 2005, gr-qc/0401087.

[OP01] R. Oeckl and H. Pfeiffer, *The dual of pure non-Abelian lattice gauge theory as a spin foam model*, Nucl. Phys. **B 598** (2001), 400–426, hep-th/0008095.

Discrete Gauge Theory Downloaded from www.worldscientific.com by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

[Oog92] H. Ooguri, *Topological lattice models in four dimensions*, Mod. Phys. Lett. **A 7** (1992), 2799–2810, hep-th/9205090.

[Ori01] D. Oriti, *Spacetime geometry from algebra: spin foam models for non-perturbative quantum gravity*, Rep. Progr. Phys. **64** (2001), 1703–1757, gr-qc/0106091.

[Pac78] U. Pachner, *Bistellare Äquivalenz kombinatorischer Mannigfaltigkeiten*, Arch. Math. **30** (1978), 89–98.

[Pac91] U. Pachner, *P.L. homeomorphic manifolds are equivalent by elementary shellings*, European J. Combin. **12** (1991), 129–145.

[Pen71a] R. Penrose, *Applications of negative dimensional tensors*, Combinatorial Mathematics and its Applications (Oxford, 1969), Academic Press, London, 1971, pp. 221–244.

[Pen71b] R. Penrose, *Angular momentum: an approach to combinatorial spacetime*, Quantum Theory and Beyond (T. Bastin, ed.), Cambridge University Press, Cambridge, 1971, pp. 151–180.

[Per03] A. Perez, *Spin foam models for quantum gravity*, Class. Quantum Grav. **20** (2003), R 43, gr-qc/0301113.

[Pfe01] H. Pfeiffer, *Four-dimensional lattice gauge theory with ribbon categories and the Crane-Yetter state sum*, J. Math. Phys. **42** (2001), 5272–5305, hep-th/0106029.

[Pfe02a] H. Pfeiffer, *Dual variables and a connection picture for the Euclidean Barrett-Crane model*, Class. Quantum Grav. **19** (2002), 1109–1137, gr-qc/0112002.

[Pfe02b] H. Pfeiffer, *Positivity of relativistic spin network evaluation*, Adv. Theor. Math. Phys. **6** (2002), 827–846, gr-qc/0211106.

[Pfe03] H. Pfeiffer, *Exact duality transformations for sigma models and gauge theories*, J. Math. Phys. **44** (2003), 2891–2938, hep-lat/0205013.

[PR68] G. Ponzano and T. Regge, *Semiclassical limit of Racah coefficients*, Spectroscopic and Group Theoretical Methods in Physics (F. Bloch et al., ed.), North-Holland, Amsterdam, 1968.

[Rei32] K. Reidemeister, *Knotentheorie*, Ergeb. Math. Grenzgeb. **1** (1932), no. 1.

[Rei97] M. P. Reisenberger, *A lattice worldsheet sum for 4-d Euclidean general relativity*, Preprint gr-qc/9711052, 1997.

[RR01] M. Reisenberger and C. Rovelli, *Spacetime as a Feynman diagram: the connection formulation*, Class. Quant. Gravity **18** (2001), 121–140, gr-qc/0002095.

[RT90] N. Yu. Reshetikhin and V. G. Turaev, *Ribbon graphs and their invariants derived from quantum groups*, Commun. Math. Phys. **127** (1990), 1–26.

[RT91] N. Yu. Reshetikhin and V. G. Turaev, *Invariants of 3-manifolds via link polynomials and quantum groups*, Invent. Math. **103** (1991), 547–597.

[Rob95] J. Roberts, *Skein theory and Turaev-Viro invariants*, Topology **34** (1995), 771–787.

[Ros02] W. Rossmann, *Lie Groups*, Oxford University Press, Oxford, 2002.

Discrete Gauge Theory Downloaded from www.worldscientific.com by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

[RS72] C. P. Rourke and B. J. Sanderson, *Introduction to Piecewise-Linear Topology*, Springer, Berlin, 1972.

[Rov98] C. Rovelli, *Loop Quantum Gravity*, Living Rev. Rel. **1** (1998), 1.

[Rov04] C. Rovelli, *Quantum gravity*, Cambridge University Press, Cambridge, 2004.

[Sav80] R. Savit, *Duality in field theory and statistical systems*, Rev. Mod. Phys. **52** (1980), 453–487.

[SNR77] M. Scheunert, W. Nahm, and V. Rittenberg, *Irreducible representations of the* $\mathfrak{osp}(2,1)$ *and* $\mathfrak{spl}(2,1)$ *graded Lie algebras*, J. Math. Phys. **18** (1977), 155–162.

[Seg88] G. Segal, *The definition of conformal field theory*, Differential geometrical methods in theoretical physics (Como, 1987), Kluwer, Dordrecht, 1988, pp. 165–171.

[Sen82] A. Sen, *Gravity as a spin system*, Phys. Lett. **B 119** (1982), 89–91.

[Sha90] I. R. Shafarevich, *Algebra I*, Springer, Berlin, 1990.

[Smo04] L. Smolin, *An invitation to loop quantum gravity*, Preprint hep-th/0408048, 2004.

[Spa66] E. H. Spanier, *Algebraic Topology*, Springer, New York, 1966.

[Swe69] M. E. Sweedler, *Hopf Algebras*, W. A. Benjamin, New York, 1969.

[Thi01] T. Thiemann, *Introduction to Modern Canonical Quantum General Relativity*, Preprint gr-qc/0110034, 2001.

[Thi05] T. Thiemann, *Modern Canonical Quantum General Relativity*, Cambridge University Press, Cambridge, 2005.

[Tur92] V. G. Turaev, *Modular categories and 3-manifold invariants*, Int. J. Mod. Phys. **B 6** (1992), 1807–1824.

[Tur94] V. G. Turaev, *Quantum Invariants of Knots and 3-Manifolds*, de Gruyter, Berlin, 1994.

[TV92] V. G. Turaev and O. Ya. Viro, *State sum invariants of 3-manifolds and quantum* $6j$*-symbols*, Topology **31** (1992), 865–902.

[Wil74] K. G. Wilson, *Confinement of quarks*, Phys. Rev. **10** (1974), 2445–2459.

[Wit89] E. Witten, $2+1$*-dimensional gravity as an exactly soluble system*, Nucl. Phys. **B 311** (1988/89), 46–78.

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

This page intentionally left blank

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

Index

$6j$-symbol, 149, 171
SU(2), 97
U(1), 96
$\mathbb{Z}$, 96
$\mathsf{U}_q(\mathfrak{su}_2)$, 101
$\mathcal{C}(\mathrm{OSp}(2;1))$, 99
$\mathcal{C}_q(\mathrm{SU}(2))$, 100
$\mathcal{C}_q(\mathrm{U}(1))$, 100
$\mathfrak{su}_2$, 97
$\mathsf{u}_q(\mathfrak{su}_2)$, 103
n-point function, 172
nj-symbol, 149
q-deformation, 100
q-integer, 102
1-lattice, 158
2-skeleton, 106

action of a groupoid, 186
algebra, 81
ambient isotopy, 37, 43
anomaly factor, 137, 161
anomaly move, 136
antipode, 82
associativity, 81

baby diagram, 17, 80
Barrett-Crane model, 166
base of a groupoid, 186
BF theory, 4
bialgebra, 82
Bianchi identity, 4
bicomodule, 92
Biedenharn-Elliot identity, 151
bistellar operation, 39
blackboard framing, 60
bosonic subgroup, 99
boundary cellular move, 47
boundary object, 126
boundary of cell, 42
boundary of simplex, 34
boundary orientation, 128
boundary state space, 131
boundary vector space, 128
braid relation, 54
braided category, 54
braiding, 54

cable, 17, 65
cable outline, 112
categorical dimension, 52
categorical trace, 52
cell, 41
cell diagram, 147
cellular coarsening move, 43
cellular decomposition, 41
cellular fusion move, 121
cellular gauge theory, 108
cellular groupoid, 188
cellular manifold, 41
cellular map, 42
cellular move, 43
cellular refining move, 43
chain mail, 154
character, 3, 17, 77

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

character group, 28
chiral component, 166
chiral model, 158
circuit diagram, 17, 65, 80
class function, 3
closed simplex, 34
coaction, 87
coalgebra, 82
coarsening, 43, 186
coassociativity, 82
cobordism, 130, 142
coevaluation, 51
combinatorial equivalence, 37
combinatorial invariance, 58
comodule, 86
complete decomposition, 60
completely reducible object, 60
completely reducible representation, 77
complex linear category, 50
configuration space, 3
continuum limit, 184
copivotal Hopf algebra, 83
coproduct, 82
coquasitriangular Hopf algebra, 83
coquasitriangular structure, 83
coribbon Hopf algebra, 84
cospherical Hopf algebra, 83
cotriangular Hopf algebra, 86
cotriangular structure, 86
counit, 82
coupling constant, 4
coupling constant, 184
coupon, 50
Crane-Yetter invariant, 150
CW-complex, 41

delta function, 13
delta identity, 20, 68
delta move, 134
dual degrees of freedom, 28
dual complex, 105
dual degrees of freedom, 157
dual lattice, 31
dual morphism, 51
dual object, 51

edge, 5
edge amplitude, 148
embedded circuit diagram, 21
embedded circuit diagram, 21, 107, 112
embedded diagram, 60
Euclidean complex, 35
Euler characteristic, 26, 44
evaluation, 51

face, 5
face amplitude, 148
Feynman diagram, 172
final vertex, 6
fusion move, 134
fusion move, 24, 43

gauge group, 2
gauge field, 2
gauge fixing, 23, 121
gauge fixing identity, 18, 66
gauge theory, 2
gauge transformation, 2, 6
generalized $6j$-symbol, 153
generating field theory, 172
geometric realization, 36
grading, 93
group field theory, 172
groupoid, 185

Haar measure, 80
heat kernel action, 16
heat kernel operator, 180
holonomy, 2
Hopf algebra, 81, 82
hyper-cubic lattice, 7

initial vertex, 6
integral, 78, 91
interaction vertex, 173
interior ambient isotopy, 37, 43
interior cellular move, 46
intertwiner, 74
inverse fusion move, 24
irreducible representation, 74
isomorphic triangulations, 37

isotopy invariance, 58

lattice, 5
lattice fusion move, 121
lattice gauge theory, 9
left action, 74
left coaction, 87
left comodule, 86
left dual, 52
left representation, 73
local action, 189
local coupling constant, 187
locally determined action, 189
loop quantum gravity, 162

matrix element, 75
matrix coalgebra, 91
matrix element, 17
modular category, 65
module of a group, 73
monoidal category, 50

non-symmetric cellular gauge theory, 109

observable, 3, 184
open simplex, 34
oriented lattice, 6
ortho-symplectic supergroup, 99
ortho-symplectic supergroup, 170

Pachner move, 39
pairing of Hopf algebras, 95
Palatini action, 165
parallel transport, 2
partition function, 12, 20, 21, 108
path integral, 12
permutation identity, 63
Peter-Weyl decomposition, 80, 93
piecewise linear, 38
pivotal category, 52
polyhedron, 35
Pontryagin duality, 97
product, 81
projected circuit diagram, 113
projected circuit diagram, 110
projected diagram, 60
propagator, 173
purification, 69

quadratic Casimir, 12
quantum $6j$-symbol, 150
quantum group, 81
quasi complete decomposition, 70
quasi completely reducible object, 70
quasi isomorphic, 70
quasi isomorphism, 70
quasi semisimple category, 70
quasitriangular structure, 103

recoupling symbol, 149
refinement, 37, 43, 186
regular cell, 42
regular cellular decomposition, 42
regulator, 183
renormalization, 183
renormalization group, 185
renormalization group flow, 185
renormalization groupoid, 187
renormalization groupoid flow, 187
representation, 73
representation space, 73
representative function, 75
Reshetikhin-Turaev invariant, 154
ribbon category, 55
ribbon form, 84
ribbon structure, 103
right representation, 74
right action, 74
right coaction, 87
right comodule, 87
right dual, 52
rigid category, 51

scale transformation, 184
semisimple category, 60
simple coalgebra, 91
simple comodule, 91
simple object, 60
simplex, 34
simplicial complex, 36
simplicial decomposition, 34

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.

simplicial map, 35, 36
spherical category, 54
spin foam, 148
spin foam model, 148
spin network, 145
state sum, 21, 108, 111, 131
strong-coupling expansion, 28
strong-weak duality, 27
supergravity, 169
supergroup, 93, 94, 98
symmetric category, 56
symmetric cellular gauge theory, 109

T-braiding, 62
T-morphism, 61
tensor product, 50
tensor product identity, 19, 67
topological quantum field theory, 142
triangulable, 37
triangulation, 37
Turaev-Viro invariant, 150
twist, 55
twisting identity, 63

ultra local action, 9
underlying polyhedron, 35
unit, 81
universal enveloping algebra, 95

vertex, 5, 34
vertex set, 36
vertex amplitude, 148

Wick rotation, 15
Wilson action, 8
Wilson loop, 3, 22, 117
Wilson network, 118, 132
wire, 17, 65

Yang-Baxter equation, 84
Yang-Mills theory, 3

Discrete Gauge Theory Downloaded from www.worldscientific.com
by 2a02:c7c:9b4d:3000:7ce7:e50d:82e2:a14f on 12/18/25. Re-use and distribution is strictly not permitted, except for Open Access articles.