

# References

1. Adams, C.C.: Thrice-punctured spheres in hyperbolic 3-manifolds. *Trans. Am. Math. Soc.* **287**(2), 645–656 (1985)
2. Adams, C.C.: Noncompact Fuchsian and quasi-Fuchsian surfaces in hyperbolic 3-manifolds. *Algebr. Geomet. Topology* **7**, 565–582 (2007)
3. Agol, I.: Lower bounds on volumes of hyperbolic Haken 3-manifolds. [arXiv:math/9906182](https://arxiv.org/abs/math/9906182)
4. Agol, I.: The virtual Haken conjecture. [arXiv:1204.2810](https://arxiv.org/abs/1204.2810). With an appendix by Ian Agol, Daniel Groves, and Jason Manning
5. Agol, I.: Criteria for virtual fibering. *J. Topology* **1**(2), 269–284 (2008). doi:10.1112/jtopol/jtn003
6. Agol, I., Storm, P.A., Thurston, W.P.: Lower bounds on volumes of hyperbolic Haken 3-manifolds. *J. Am. Math. Soc.* **20**(4), 1053–1077 (2007). With an appendix by Nathan Dunfield
7. Andreev, E.M.: Convex polyhedra in Lobachevskii spaces. *Mat. Sb. (N.S.)* **81**(123), 445–478 (1970)
8. Andreev, E.M.: Convex polyhedra of finite volume in Lobachevskii space. *Mat. Sb. (N.S.)* **83**(125), 256–260 (1970)
9. Armond, C., Dasbach, O.T.: Rogers–Ramanujan type identities and the head and tail of the colored Jones polynomial. [arXiv:1106.3948](https://arxiv.org/abs/1106.3948)
10. Atiyah, M.: *The Geometry and Physics of Knots. Lezioni Lincee [Lincei Lectures]*. Cambridge University Press, Cambridge (1990). doi:10.1017/CBO9780511623868
11. Atkinson, C.K.: Two-sided combinatorial volume bounds for non-obtuse hyperbolic polyhedra. *Geometriae Dedicata* **153**(1), 177–211 (2011)
12. Bollobás, B., Riordan, O.: A polynomial invariant of graphs on orientable surfaces. *Proc. Lond. Math. Soc. (3)* **83**(3), 513–531 (2001). doi:10.1112/plms/83.3.513
13. Bollobás, B., Riordan, O.: A polynomial of graphs on surfaces. *Math. Ann.* **323**(1), 81–96 (2002). doi:10.1007/s002080100297
14. Bonahon, F., Siebenmann, L.: *New Geometric Splittings of Classical Knots, and the Classification and Symmetries of Arborescent Knots. Geometry and Topology Monographs (to appear)*. <http://www-bcf.usc.edu/~fbonahon/Research/Preprints/Preprints.html>
15. Burde, G., Zieschang, H.: *Knots. de Gruyter Studies in Mathematics, vol. 5, 2nd edn.* Walter de Gruyter, Berlin (2003)
16. Calegari, D., Freedman, M.H., Walker, K.: Positivity of the universal pairing in 3 dimensions. *J. Am. Math. Soc.* **23**(1), 107–188 (2010). doi:10.1090/S0894-0347-09-00642-0
17. Cha, J.C., Livingston, C.: *Knotinfo: Table of knot invariants* (2012) <http://www.indiana.edu/~knotinfo>
18. Champanerkar, A., Kofman, I., Patterson, E.: The next simplest hyperbolic knots. *J. Knot Theor. Ramifications* **13**(7), 965–987 (2004)

19. Cromwell, P.R.: Homogeneous links. *J. Lond. Math. Soc.* (2) **39**(3), 535–552 (1989). doi:10.1112/jlms/s2-39.3.535
20. Culler, M., Shalen, P.B.: Volumes of hyperbolic Haken manifolds. I. *Invent. Math.* **118**(2), 285–329 (1994). doi:10.1007/BF01231535
21. Dasbach, O.T., Futer, D., Kalfagianni, E., Lin, X.S., Stoltzfus, N.W.: The Jones polynomial and graphs on surfaces. *J. Combin. Theor. Ser. B* **98**(2), 384–399 (2008)
22. Dasbach, O.T., Futer, D., Kalfagianni, E., Lin, X.S., Stoltzfus, N.W.: Alternating sum formulae for the determinant and other link invariants. *J. Knot Theor. Ramifications* **19**(6), 765–782 (2010)
23. Dasbach, O.T., Lin, X.S.: On the head and the tail of the colored Jones polynomial. *Compos. Math.* **142**(5), 1332–1342 (2006)
24. Dasbach, O.T., Lin, X.S.: A volume-ish theorem for the Jones polynomial of alternating knots. *Pac. J. Math.* **231**(2), 279–291 (2007)
25. Dimofte, T., Gukov, S.: Quantum field theory and the volume conjecture. *Contemp. Math.* **541**, 41–68 (2011)
26. Dunfield, N.M., Garoufalidis, S.: Incompressibility criteria for spun-normal surfaces. *Trans. Am. Math. Soc.* **364**(11), 6109–6137 (2012). doi:10.1090/S0002-9947-2012-05663-7
27. Eudave Muñoz, M.: Band sums of links which yield composite links. The cabling conjecture for strongly invertible knots. *Trans. Am. Math. Soc.* **330**(2), 463–501 (1992). doi:10.2307/2153918
28. Freyd, P., Yetter, D.N., Hoste, J., Lickorish, W.B.R., Millett, K.C., Ocneanu, A.: A new polynomial invariant of knots and links. *Bull. Am. Math. Soc. (N.S.)* **12**(2), 239–246 (1985). doi:10.1090/S0273-0979-1985-15361-3
29. Futer, D.: Fiber detection for state surfaces. arXiv:1201.1643 (2012)
30. Futer, D., Guéritaud, F.: Angled decompositions of arborescent link complements. *Proc. Lond. Math. Soc.* (3) **98**(2), 325–364 (2009). doi:10.1112/plms/pdn033
31. Futer, D., Kalfagianni, E., Purcell, J.S.: Quasifuchsian state surfaces. ArXiv:1209.5719 (2012)
32. Futer, D., Kalfagianni, E., Purcell, J.S.: Dehn filling, volume, and the Jones polynomial. *J. Differ. Geom.* **78**(3), 429–464 (2008)
33. Futer, D., Kalfagianni, E., Purcell, J.S.: Symmetric links and Conway sums: volume and Jones polynomial. *Math. Res. Lett.* **16**(2), 233–253 (2009)
34. Futer, D., Kalfagianni, E., Purcell, J.S.: Cusp areas of Farey manifolds and applications to knot theory. *Int. Math. Res. Not. IMRN* **2010**(23), 4434–4497 (2010)
35. Futer, D., Kalfagianni, E., Purcell, J.S.: On diagrammatic bounds of knot volumes and spectral invariants. *Geometriae Dedicata* **147**, 115–130 (2010). doi:10.1007/s10711-009-9442-6
36. Futer, D., Kalfagianni, E., Purcell, J.S.: Slopes and colored Jones polynomials of adequate knots. *Proc. Am. Math. Soc.* **139**, 1889–1896 (2011)
37. Futer, D., Kalfagianni, E., Purcell, J.S.: Jones polynomials, volume, and essential knot surfaces: a survey. In: *Proceedings of Knots in Poland III*. Banach Center Publications (to appear)
38. Futer, D., Purcell, J.S.: Links with no exceptional surgeries. *Comment. Math. Helv.* **82**(3), 629–664 (2007). doi:10.4171/CMH/105
39. Gabai, D.: The Murasugi sum is a natural geometric operation. In: *Low-Dimensional Topology* (San Francisco, CA, 1981). Contemporary Mathematics, vol. 20, pp. 131–143. American Mathematical Society, Providence (1983)
40. Gabai, D.: Detecting fibred links in  $S^3$ . *Comment. Math. Helv.* **61**(4), 519–555 (1986). doi:10.1007/BF02621931
41. Garoufalidis, S.: The degree of a  $q$ -holonomic sequence is a quadratic quasi-polynomial. *Electron. J. Combin.* **18**(2), Paper 4, 23 (2011)
42. Garoufalidis, S.: The Jones slopes of a knot. *Quant. Topology* **2**(1), 43–69 (2011). doi:10.4171/QT/13
43. Garoufalidis, S., Lê, T.T.Q.: The colored Jones function is  $q$ -holonomic. *Geom. Topology* **9**, 1253–1293 (electronic) (2005). doi:10.2140/gt.2005.9.1253
44. Gromov, M.: Volume and bounded cohomology. *Inst. Hautes Études Sci. Publ. Math.* (56), 5–99 (1982/1983)

45. Guéritaud, F., Futer, D. (appendix): On canonical triangulations of once-punctured torus bundles and two-bridge link complements. *Geom. Topology* **10**, 1239–1284 (2006)
46. Hoste, J., Thistlethwaite, M.B.: *Knotscape* (2012) <http://www.math.utk.edu/~morwen>
47. Jaco, W.H., Shalen, P.B.: Seifert fibered spaces in 3-manifolds. *Mem. Am. Math. Soc.* **21**(220), viii+192 (1979)
48. Johansson, K.: *Homotopy Equivalences of 3-Manifolds with Boundaries*. Lecture Notes in Mathematics, vol. 761. Springer, Berlin (1979)
49. Jones, V.F.R.: A polynomial invariant for knots via von Neumann algebras. *Bull. Am. Math. Soc. (N.S.)* **12**(1), 103–111 (1985). doi:10.1090/S0273-0979-1985-15304-2
50. Jones, V.F.R.: Hecke algebra representations of braid groups and link polynomials. *Ann. Math. (2)* **126**(2), 335–388 (1987)
51. Jørgensen, T.: Compact 3-manifolds of constant negative curvature fibering over the circle. *Ann. Math. (2)* **106**(1), 61–72 (1977)
52. Kashaev, R.M.: Quantum dilogarithm as a  $6j$ -symbol. *Mod. Phys. Lett. A* **9**(40), 3757–3768 (1994). doi:10.1142/S0217732394003610
53. Kashaev, R.M.: A link invariant from quantum dilogarithm. *Mod. Phys. Lett. A* **10**(19), 1409–1418 (1995). doi:10.1142/S0217732395001526
54. Kashaev, R.M.: The hyperbolic volume of knots from the quantum dilogarithm. *Lett. Math. Phys.* **39**(3), 269–275 (1997)
55. Kauffman, L.H.: State models and the Jones polynomial. *Topology* **26**(3), 395–407 (1987). doi:10.1016/0040-9383(87)90009-7
56. Kauffman, L.H.: An invariant of regular isotopy. *Trans. Am. Math. Soc.* **318**(2), 417–471 (1990). doi:10.2307/2001315
57. Kuessner, T.: Guts of surfaces in punctured-torus bundles. *Arch. Math. (Basel)* **86**(2), 176–184 (2006). doi:10.1007/s00013-005-1097-4
58. Lackenby, M.: The volume of hyperbolic alternating link complements. *Proc. Lond. Math. Soc. (3)* **88**(1), 204–224 (2004). With an appendix by Ian Agol and Dylan Thurston
59. Lackenby, M.: Classification of alternating knots with tunnel number one. *Comm. Anal. Geom.* **13**(1), 151–185 (2005)
60. Lickorish, W.B.R.: *An Introduction to Knot Theory*. Graduate Texts in Mathematics, vol. 175. Springer, New York (1997)
61. Lickorish, W.B.R., Thistlethwaite, M.B.: Some links with nontrivial polynomials and their crossing-numbers. *Comment. Math. Helv.* **63**(4), 527–539 (1988)
62. Luft, E., Zhang, X.: Symmetric knots and the cabling conjecture. *Math. Ann.* **298**(3), 489–496 (1994). doi:10.1007/BF01459747
63. Manchón, P.M.G.: Extreme coefficients of Jones polynomials and graph theory. *J. Knot Theor. Ramifications* **13**(2), 277–295 (2004). doi:10.1142/S0218216504003135
64. Menasco, W.W.: Polyhedra representation of link complements. In: *Low-Dimensional Topology* (San Francisco, CA, 1981). Contemporary Mathematics, vol. 20, pp. 305–325. American Mathematical Society, Providence (1983)
65. Menasco, W.W.: Closed incompressible surfaces in alternating knot and link complements. *Topology* **23**(1), 37–44 (1984). doi:10.1016/0040-9383(84)90023-5
66. Menasco, W.W., Thistlethwaite, M.B.: Surfaces with boundary in alternating knot exteriors. *J. Reine Angew. Math.* **426**, 47–65 (1992)
67. Menasco, W.W., Thistlethwaite, M.B.: The classification of alternating links. *Ann. Math. (2)* **138**(1), 113–171 (1993). doi:10.2307/2946636
68. Miyamoto, Y.: Volumes of hyperbolic manifolds with geodesic boundary. *Topology* **33**(4), 613–629 (1994). doi:10.1016/0040-9383(94)90001-9
69. Morgan, J., Tian, G.: *Ricci Flow and the Poincaré Conjecture*. Clay Mathematics Monographs, vol. 3. American Mathematical Society, Providence (2007)
70. Moser, L.: Elementary surgery along a torus knot. *Pac. J. Math.* **38**, 737–745 (1971)
71. Mostow, G.D.: Quasi-conformal mappings in  $n$ -space and the rigidity of hyperbolic space forms. *Inst. Hautes Études Sci. Publ. Math.* (34), 53–104 (1968)

72. Murakami, H.: An introduction to the volume conjecture. In: *Interactions Between Hyperbolic Geometry, Quantum Topology and Number Theory*. Contemporary Mathematics, vol. 541, pp. 1–40. American Mathematical Society, Providence (2011). doi:10.1090/conm/541/10677
73. Murakami, H., Murakami, J.: The colored Jones polynomials and the simplicial volume of a knot. *Acta Math.* **186**(1), 85–104 (2001)
74. Murasugi, K.: Jones polynomials and classical conjectures in knot theory. *Topology* **26**(2), 187–194 (1987). doi:10.1016/0040-9383(87)90058-9
75. Ni, Y.: Knot Floer homology detects fibred knots. *Invent. Math.* **170**(3), 577–608 (2007). doi:10.1007/s00222-007-0075-9
76. Ozawa, M.: Essential state surfaces for knots and links. *J. Aust. Math. Soc.* **91**(3), 391–404 (2011)
77. Ozsváth, P., Szabó, Z.: Holomorphic disks and genus bounds. *Geom. Topology* **8**, 311–334 (2004). doi:10.2140/gt.2004.8.311
78. Ozsváth, P., Szabó, Z.: Link Floer homology and the Thurston norm. *J. Am. Math. Soc.* **21**(3), 671–709 (2008). doi:10.1090/S0894-0347-08-00586-9
79. Perelman, G.: The entropy formula for the Ricci flow and its geometric applications. arXiv:math.DG/0211159 (2002)
80. Perelman, G.: Ricci flow with surgery on three-manifolds. arXiv:math.DG/0303109 (2003)
81. Petronio, C.: Spherical splitting of 3-orbifolds. *Math. Proc. Camb. Phil. Soc.* **142**(2), 269–287 (2007). doi:10.1017/S0305004106009807
82. Prasad, G.: Strong rigidity of  $\mathbf{Q}$ -rank 1 lattices. *Invent. Math.* **21**, 255–286 (1973)
83. Przytycki, J.H.: From Goeritz matrices to quasi-alternating links. In: *The Mathematics of Knots. Contributions in Mathematical and Computational Sciences*, vol. 1, pp. 257–316. Springer, Heidelberg (2011). doi:10.1007/978-3-642-15637-3\_9
84. Reshetikhin, N., Turaev, V.G.: Ribbon graphs and their invariants derived from quantum groups. *Comm. Math. Phys.* **127**(1), 1–26 (1990)
85. Reshetikhin, N., Turaev, V.G.: Invariants of 3-manifolds via link polynomials and quantum groups. *Invent. Math.* **103**(3), 547–597 (1991). doi:10.1007/BF01239527
86. Riley, R.: Discrete parabolic representations of link groups. *Mathematika* **22**(2), 141–150 (1975)
87. Riley, R.: A quadratic parabolic group. *Math. Proc. Camb. Phil. Soc.* **77**, 281–288 (1975)
88. Scharlemann, M.: Producing reducible 3-manifolds by surgery on a knot. *Topology* **29**(4), 481–500 (1990). doi:10.1016/0040-9383(90)90017-E
89. Stallings, J.R.: Constructions of fibred knots and links. In: *Algebraic and Geometric Topology (Proceedings of Symposia in Pure Mathematics, Stanford University, Stanford, CA, 1976)*. Part 2, *Proceedings of Symposia in Pure Mathematics*, vol. XXXII, pp. 55–60. American Mathematical Society, Providence (1978)
90. Stoimenow, A.: Coefficients and non-triviality of the Jones polynomial. *J. Reine Angew. Math.* **657**, 1–55 (2011)
91. Stoimenow, A.: On the crossing number of semi-adequate links. *Forum Math.* (in press). doi:10.1515/forum-2011-0121
92. Thistlethwaite, M.B.: On the Kauffman polynomial of an adequate link. *Invent. Math.* **93**(2), 285–296 (1988). doi:10.1007/BF01394334
93. Thurston, W.P.: Three-dimensional manifolds, Kleinian groups and hyperbolic geometry. *Bull. Am. Math. Soc. (N.S.)* **6**(3), 357–381 (1982)
94. Thurston, W.P.: A norm for the homology of 3-manifolds. *Mem. Am. Math. Soc.* **59**(339), i–vi and 99–130 (1986)
95. Turaev, V.G.: A simple proof of the Murasugi and Kauffman theorems on alternating links. *Enseign. Math.* (2) **33**(3–4), 203–225 (1987)
96. Witten, E.: 2 + 1-dimensional gravity as an exactly soluble system. *Nucl. Phys. B* **311**(1), 46–78 (1988/1989). doi:10.1016/0550-3213(88)90143-5
97. Witten, E.: Quantum field theory and the Jones polynomial. *Comm. Math. Phys.* **121**(3), 351–399 (1989)

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Edited by J.-M. Morel, B. Teissier; P.K. Maini

**Editorial Policy** (for the publication of monographs)

1. Lecture Notes aim to report new developments in all areas of mathematics and their applications - quickly, informally and at a high level. Mathematical texts analysing new developments in modelling and numerical simulation are welcome.

Monograph manuscripts should be reasonably self-contained and rounded off. Thus they may, and often will, present not only results of the author but also related work by other people. They may be based on specialised lecture courses. Furthermore, the manuscripts should provide sufficient motivation, examples and applications. This clearly distinguishes Lecture Notes from journal articles or technical reports which normally are very concise. Articles intended for a journal but too long to be accepted by most journals, usually do not have this “lecture notes” character. For similar reasons it is unusual for doctoral theses to be accepted for the Lecture Notes series, though habilitation theses may be appropriate.

2. Manuscripts should be submitted either online at [www.editorialmanager.com/lnm](http://www.editorialmanager.com/lnm) to Springer’s mathematics editorial in Heidelberg, or to one of the series editors. In general, manuscripts will be sent out to 2 external referees for evaluation. If a decision cannot yet be reached on the basis of the first 2 reports, further referees may be contacted: The author will be informed of this. A final decision to publish can be made only on the basis of the complete manuscript, however a refereeing process leading to a preliminary decision can be based on a pre-final or incomplete manuscript. The strict minimum amount of material that will be considered should include a detailed outline describing the planned contents of each chapter, a bibliography and several sample chapters. Authors should be aware that incomplete or insufficiently close to final manuscripts almost always result in longer refereeing times and nevertheless unclear referees’ recommendations, making further refereeing of a final draft necessary. Authors should also be aware that parallel submission of their manuscript to another publisher while under consideration for LNM will in general lead to immediate rejection.

3. Manuscripts should in general be submitted in English. Final manuscripts should contain at least 100 pages of mathematical text and should always include

- a table of contents;
- an informative introduction, with adequate motivation and perhaps some historical remarks: it should be accessible to a reader not intimately familiar with the topic treated;
- a subject index: as a rule this is genuinely helpful for the reader.

For evaluation purposes, manuscripts may be submitted in print or electronic form (print form is still preferred by most referees), in the latter case preferably as pdf- or zipped psfiles. Lecture Notes volumes are, as a rule, printed digitally from the authors’ files. To ensure best results, authors are asked to use the LaTeX2e style files available from Springer’s web-server at:

<ftp://ftp.springer.de/pub/tex/latex/svmonot1/> (for monographs) and

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Additional technical instructions, if necessary, are available on request from [lnm@springer.com](mailto:lnm@springer.com).

4. Careful preparation of the manuscripts will help keep production time short besides ensuring satisfactory appearance of the finished book in print and online. After acceptance of the manuscript authors will be asked to prepare the final LaTeX source files and also the corresponding dvi-, pdf- or zipped ps-file. The LaTeX source files are essential for producing the full-text online version of the book (see <http://www.springerlink.com/openurl.asp?genre=journal&issn=0075-8434> for the existing online volumes of LNM). The actual production of a Lecture Notes volume takes approximately 12 weeks.
5. Authors receive a total of 50 free copies of their volume, but no royalties. They are entitled to a discount of 33.3 % on the price of Springer books purchased for their personal use, if ordering directly from Springer.
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