

## References

- [1] V. Alvarez, J.A. Armario, M.D. Frau, and P. Real. Calculating cocyclic hadamard matrices in mathematica: Exhaustive and heuristic searches. In Andres Iglesias and Nobuki Takayama, editors, *Mathematical Software - ICMS 2006*, volume 4151 of *Lecture Notes in Computer Science*, pages 419–422. Springer Berlin Heidelberg, 2006.
- [2] N. Andruskiewitsch, C. Galindo, and M. Müller. Examples of finite-dimensional Hopf algebras with the dual Chevalley property. *ArXiv e-prints*, September 2015.
- [3] Zekeriya Arvasi, Alper Odabaş, and Christopher D. Wensley. Computing 3-Dimensional Groups : Crossed Squares and  $\text{Cat}^2$ -Groups. *arXiv e-prints*, page arXiv:1911.12799, Nov 2019.
- [4] Anh Tuan B and Anh Thi N. A brief introduction to the Quillen conjecture. *Sci. Tech. Dev. J.*, 22(2):235–238, 2019.
- [5] J.S. Bailes. *Cohen-Lenstra Heuristics and the Cohomology of the Braid Group*. PhD thesis, University of Melbourne. University of Melbourne, 2011.
- [6] Mohamed Barakat. The homomorphism theorem and effective computations. *Habilitationsschrift, Aachen* <http://www.mathb.rwth-aachen.de/~barakat/habil/habil.pdf>, 2018.
- [7] Ethan Berkove and Alexander D. Rahm. The mod 2 cohomology rings of  $\text{SL}_2$  of the imaginary quadratic integers. *J. Pure Appl. Algebra*, 220(3):944–975, 2016. With an appendix by Aurel Page.
- [8] Anna M. Bigatti and E. Sáenz-de Cabezón. Computation of the  $(n - 1)$ -st Koszul homology of monomial ideals and related algorithms. In *ISSAC 2009—Proceedings of the 2009 International Symposium on Symbolic and Algebraic Computation*, pages 31–37. ACM, New York, 2009.
- [9] L.R. Bosko. *Schur Multipliers of Nilpotent Lie Algebras*. BiblioBazaar, 2012.
- [10] Rachel Boyd. Erratum to: Low-dimensional homology of finite-rank coxeter groups. <https://guests.mpim-bonn.mpg.de/rachaelboyd/Erratum.pdf>, 2021.
- [11] Piotr Brendel, Pawel Dlotko, Graham Ellis, Mateusz Juda, and Marian Mrozek. Computing fundamental groups from point clouds. *Applicable Algebra in Engineering, Communication and Computing*, 26(1-2):27–48, 2015.
- [12] A. T. Bui and Graham Ellis. Computing bredon homology of groups. *Journal of Homotopy and Related Structures*, 11(4):715–734, 2016.

- [13] A.T. Bui, A. Rahm, and M. Wendt. The Farrell-Tate and Bredon homology for  $PSL_4(\mathbb{Z})$  and other arithmetic groups. *ArXiv e-prints*, November 2016.
- [14] M. Bulcan, L. Li, and R. Radhakrishnan.  $a \times b = c$  in  $2 + 1d$  tqft. *arXiv e-prints*, page arXiv:2012.14689, Dec 2020.
- [15] Martin Čadek, Marek Krčál, Jiří Matoušek, Lukáš Vokřínek, and Uli Wagner. Polynomial-time computation of homotopy groups and Postnikov systems in fixed dimension. *SIAM J. Comput.*, 43(5):1728–1780, 2014.
- [16] Filippo Callegaro and Ivan Marin. Homology computations for complex braid groups. *arXiv*, 1011.4375, 2010.
- [17] Peter J. Cameron. Graphs defined on groups. *arXiv*, 2102.11177, 2021.
- [18] Manuela Cerdeiro. Un nuevo enfoque sobre la conjetura de whitehead y la asfericidad delos complejos lot. *PhD thesis, Universidad de Buenos Aires en el area Ciencias Matematicas*, 2015.
- [19] Erin Wolf Chambers and Mikael Vejdemo-Johansson. Computing minimum area homologies. *Computer Graphics Forum*, 34(6):13–21, 2015.
- [20] Rocco Chirivì and Mauro Spreafico. Space forms and group resolutions: the tetrahedral family. *J. Algebra*, 510:52–97, 2018.
- [21] Maura Clancy and Graham Ellis. Homology of some Artin and twisted Artin groups. *J. K-Theory*, 6(1):171–196, 2010.
- [22] I.S. Costa. Presentation complexes with the fixed point property. *Geometry and Topology*, 21:1275–1283, 2017.
- [23] I.S. Costa. Puntos fijos de acciones y funciones en 2-complejos. *PhD thesis, Universidad de Buenos Aires*, 2019.
- [24] Rodrigo de Almelda Rosa. *Cálculo de grupos fundamentais de nuvens de pontos através de técnicas de Análise Topológica de Dados*. São Paulo State University - International, Masters thesis, 2021.
- [25] Paul de Lange. The physics & mathematics of microstates in string theory and a monstrous farey tail. *PhD thesis, Univ. van Amsterdam*, 2016.
- [26] Heiko Dietrich, Bettina Eick, and Dörte Feichtenschlager. Investigating  $p$ -groups by coclass with GAP. In *Computational group theory and the theory of groups*, volume 470 of *Contemp. Math.*, pages 45–61. Amer. Math. Soc., Providence, RI, 2008.
- [27] Mathieu Dutour Sikirić and Graham Ellis. Wythoff polytopes and low-dimensional homology of Mathieu groups. *J. Algebra*, 322(11):4143–4150, 2009.

- [28] Mathieu Dutour Sikirić, Graham Ellis, and Achill Schürmann. On the integral homology of  $\mathrm{PSL}_4(\mathbb{Z})$  and other arithmetic groups. *J. Number Theory*, 131(12):2368–2375, 2011.
- [29] E.G.Minian and K.I. Piterman. The fundamental group of the  $p$ -subgroup complex. *arXiv e-prints*, page arXiv:1903.03549, Mar 2019.
- [30] G. Ellis and K. Killeen. Cohomology with local coefficients and knotted manifolds. *Journal Symbolic Computation (to appear)*, 2021.
- [31] Graham Ellis. Homological algebra programming. In *Computational group theory and the theory of groups*, volume 470 of *Contemp. Math.*, pages 63–74. Amer. Math. Soc., Providence, RI, 2008.
- [32] Graham Ellis. Cohomological periodicities of crystallographic groups. *J. Algebra*, 445:537–544, 2016.
- [33] Graham Ellis. *An invitation to computational homotopy*. Oxford University Press, Oxford, 2019.
- [34] Graham Ellis and Fintan Hegarty. Computational homotopy of finite regular CW-spaces. *J. Homotopy Relat. Struct.*, 9(1):25–54, 2014.
- [35] Graham Ellis and Simon King. Persistent homology of groups. *J. Group Theory*, 14(4):575–587, 2011.
- [36] Graham Ellis and Luyen Van Le. Homotopy 2-types of low order. *Exp. Math.*, 23(4):383–389, 2014.
- [37] Graham Ellis and Le Van Luyen. Computational homology of  $n$ -types. *J. Symbolic Comput.*, 47(11):1309–1317, 2012.
- [38] Graham Ellis and Roman Mikhailov. A colimit of classifying spaces. *Adv. Math.*, 223(6):2097–2113, 2010.
- [39] Graham Ellis, Hamid Mohammadzadeh, and Hamid Tavallaee. Computing covers of Lie algebras. In *Computational group theory and the theory of groups, II*, volume 511 of *Contemp. Math.*, pages 25–31. Amer. Math. Soc., Providence, RI, 2010.
- [40] Graham Ellis and Emil Sköldbberg. The  $K(\pi, 1)$  conjecture for a class of Artin groups. *Comment. Math. Helv.*, 85(2):409–415, 2010.
- [41] Graham Ellis and Paul Smith. Computing group cohomology rings from the Lyndon-Hochschild-Serre spectral sequence. *J. Symbolic Comput.*, 46(4):360–370, 2011.
- [42] Dominic Else and Ryan Thorngren. Topological theory of lieb-schultz-mattis theorems in quantum spin systems. *arXiv:1907.08204*, 2019.

- [43] P. Fernández Ascariz. *Módulos cruzados de álgebras conmutativas, homología y HAP*. Teses de doutoramento da Universidade de Santiago de Compostela. Universidad de Santiago de Compostela, Servizo de Publicacións e Intercambio Científico, 2007.
- [44] Matthias R. Gaberdiel, Daniel Persson, Henrik Ronellenfitsch, and Roberto Volpato. Generalized Mathieu Moonshine. *Commun. Number Theory Phys.*, 7(1):145–223, 2013.
- [45] Terry Gannon and Corey Jones. Vanishing of categorical obstructions for permutation orbifolds. *arXiv:1804.08343*, 2018.
- [46] Giles Gardam. Low-dimensional homology of finite coxeter groups. *Zenodo*, 10.5281/zenodo.4758008, May 2021.
- [47] Angus Gruen. Computing modular data for drinfeld centers of pointed fusion categories. *Bachelor thesis, The Mathematical Sciences Institute, Australian National University*, 2017.
- [48] Angus Gruen and Scott Morrison. Computing modular data for pointed fusion categories. *Indiana Univ. Math. J.*, 70(2):561–593, 2021.
- [49] S. Hatui. A characterization of finite  $p$ -groups by their schur multiplier. *arXiv:1608.06322*, 2016.
- [50] Sumana Hatui. Finite  $p$ -groups having Schur multiplier of maximum order. *J. Algebra*, 492:490–497, 2017.
- [51] Sumana Hatui, Vipul Kakkar, and Manoj K. Yadav. The Schur multiplier of groups of order  $p^5$ . *J. Group Theory*, 22(4):647–687, 2019.
- [52] F. Hegarty. *Computational Homology of Cubical and Permutahedral Complexes*. PhD thesis, National University of Ireland Galway. National University of Ireland Galway, 2012.
- [53] Jónathan Heras, Vico Pascual, Ana Romero, and Julio Rubio. Integrating multiple sources to answer questions in algebraic topology. In *Intelligent computer mathematics. 10th international conference, AISC 2010, 17th symposium, Calculemus 2010, and 9th international conference, MKM 2010, Paris, France, July 5–10, 2010. Proceedings*, pages 331–335. Berlin: Springer, 2010.
- [54] Jónathan Heras, Vico Pascual, and Julio Rubio. Using open mathematical documents to interface computer algebra and proof assistant systems. In *Intelligent computer mathematics. 16th symposium, Calculemus 2009, 8th international conference, MKM 2009, held as part of CICM 2009, Grand Bend, Canada, July 6–12, 2009. Proceedings*, pages 467–473. Berlin: Springer, 2009.

- [55] Jónathan Heras, Vico Pascual, and Julio Rubio. A system for computing and reasoning in algebraic topology. In JamesH. Davenport, WilliamM. Farmer, Josef Urban, and Florian Rabe, editors, *Intelligent Computer Mathematics*, volume 6824 of *Lecture Notes in Computer Science*, pages 295–297. Springer Berlin Heidelberg, 2011.
- [56] A. Holzinger. On topological data mining. *Lecture Notes in Computer Science*, 8401:331–356, 2014.
- [57] Andreas Holzinger and Igor Jurisica. Knowledge discovery and data mining in biomedical informatics: The future is in integrative, interactive machine learning solutions. In *Interactive Knowledge Discovery and Data Mining in Biomedical Informatics - State-of-the-Art and Future Challenges*, pages 1–18. 2014.
- [58] A. Hoshi, K. Kanai, and A. Yamasaki. Norm one tori and hasse norm principle, ii: degree 12 case. *arXiv e-prints*, page arXiv:2003.08253, Dec 2020.
- [59] A. Hoshi, M.-c. Kang, and A. Yamasaki. Multiplicative invariant fields of dimension  $\leq 6$ . *arXiv.org*, *arXiv:1609.04142*, pages 1–105, 2016.
- [60] A. Hoshi, M.-c. Kang, and A. Yamasaki. Degree three unramified groups and noether’s problem for groups of order 243. *arXiv.org*, *arXiv:1710.01958*, pages 1–61, 2017.
- [61] Akinari Hoshi, Kazuki Kanai, and Aiichi Yamasaki. Norm one tori and hasse norm principle, 2021.
- [62] Akinari Hoshi and Aiichi Yamasaki. Rationality problem for algebraic tori. *Mem. American Math. Soc. (to appear)*, pages 1–146, 2016.
- [63] U. Jezernik. *Universal Commutator Relations*. PhD thesis, University of Ljubljana. University of Ljubljana, 2016.
- [64] Urban Jezernik and Primož Moravec. Bogomolov multipliers of groups of order 128. *Exp. Math.*, 23(2):174–180, 2014.
- [65] T. Johnson-Freyd. The moonshine anomaly. *arXiv:1707.08388*, pages 1–15, 2017.
- [66] T. Johnson-Freyd and D. Treumann.  $H^4(C_{00}; \mathbb{Z}) = \mathbb{Z}_{24}$ . *arXiv:1707.07587v1*, pages 1–14, 2017.
- [67] T. Johnson-Freyd and D. Treumann. Third homology of some sporadic finite groups. *arXiv:arXiv:1810.00463v1*, pages 1–29, 2018.
- [68] A. Joshi. *MATHIEU MOONSHINE: From  $M_{24}$  to  $M_{12}$* . MSc thesis, IIT Madras. Indian Institute of Technology Madras, 2016.

- [69] David Joyner. A primer on computational group homology and cohomology using GAP and SAGE. In *Aspects of infinite groups*, volume 1 of *Algebra Discrete Math.*, pages 159–191. World Sci. Publ., Hackensack, NJ, 2008.
- [70] Tomasz Kaczynski and Marian Mrozek. The cubical cohomology ring: an algorithmic approach. *Found. Comput. Math.*, 13(5):789–818, 2013.
- [71] M.-C. Kang and B. Kunyavskii. The bogomolov multiplier of rigid finite groups. *Archiv der Mathematik*, pages 209–218, 102 2014.
- [72] Anton Kapustin and Ryan Thorngren. Anomalous discrete symmetries in three dimensions and group cohomology. *Phys. Rev. Lett.*, 112:231602, Jun 2014.
- [73] V. Kurlin. Computing invariants of knotted graphs given by sequences of points in 3-dimensional space. *Topological methods in data analysis and visualization IV : theory, algorithms, and applications. Mathematics and visualization. (Springer)*, 2017.
- [74] Larry A. Lambe. An algebraic study of the Klein bottle. *J. Homotopy Relat. Struct.*, 11(4):885–891, 2016.
- [75] J.Y. Lee, A. Turner, and A. Vishwanaith. Building symmetry enriched topological phases from a bipartite lattice construction and anyon condensation. *arXiv e-prints*, page arXiv:1802.02155, Feb 2018.
- [76] Rafał Lutowski and Bartosz Putrycz. Spin structures on flat manifolds. *J. Algebra*, 436:277–291, 2015.
- [77] I. Michailov, I. Ivanov, A. Aleksandrina, and G. Llianova. Algorithmic determination of isoclinism classes for 6-generator groups of nilpotency class 2. *Proceedings of the University of Ruse Conference, 2015*. <http://conf.uni-ruse.bg/bg/docs/cp15/6.1/6.1-4.pdf>, pages 24–27, 2015.
- [78] I. Michailov, I. Ivanov, and N. Ziapkov. Algorithmic generation of isoclinism classes for 4-generator groups of nilpotency class 2. *Proceedings of the University of Ruse Conference, 2015*. <http://conf.uni-ruse.bg/bg/docs/cp15/6.1/6.1-3.pdf>, pages 24–27, 2015.
- [79] Pascal Michel. Homology of groups and third busy beaver function. *Internat. J. Algebra Comput.*, 20(6):769–791, 2010.
- [80] M. Mignard and P. Schauenburg. Morita equivalence of pointed fusion categories of small rank. *HAL Id: hal-01573708*, pages 1–46, 2017.
- [81] Roman Mikhailov and Jie Wu. On homotopy groups of the suspended classifying spaces. *Algebr. Geom. Topol.*, 10(1):565–625, 2010.

- [82] Yasushi Mizusawa. On certain 2-extensions of  $\mathbb{Q}$  unramified at 2 and  $\infty$ . *Osaka J. Math.*, 53(4):1063–1088, 10 2016.
- [83] Mohammad Reza R. Moghaddam and Peyman Niroomand. Some properties of certain subgroups of tensor squares of  $p$ -groups. *Comm. Algebra*, 40(3):1188–1193, 2012.
- [84] M. Muller Lopes Rocha. *Ejemplos de algebras de Hopf semisimples y de algebras de Hopf con la propiedad de Chevalley dual*. PhD thesis, Universidad National de Cordoba. University Universidad National de Cordoba, 2016.
- [85] D. Müllner. *Orientation Reversal of Manifolds*. Bonner mathematische Schriften. D. Müllner, 2008.
- [86] Neha Nanda, Mahender Singh, and Manpreet Singh. Knot invariants from derivations of quandles. *arXiv:1804.01113*, 2018.
- [87] Afifi Nawi, Nor Ali, Nor Muhainiah Mohd, and Nor Haniza Sarmin. Aip conference proceedings 2266, 060002 (2020); <https://doi.org/10.1063/5.00183402266>, 060002© 2020 author(s).the computation of schur multiplier and capability of pairs of groups of order  $p^4$ . *AIP Conference Proceedings 2266*, 2020.
- [88] P. Niroomand and R. Rezaei. On the exterior degree of finite groups. *Comm. Algebra*, 39(1):335–343, 2011.
- [89] Peyman Niroomand and Rashid Rezaei. The exterior degree of a pair of finite groups. *Mediterr. J. Math.*, 10(3):1195–1206, 2013.
- [90] Peyman Niroomand and Francesco G. Russo. Probabilistic properties of the relative tensor degree of finite groups. *Indagationes Mathematicae*, 27(1):147–159, 2016.
- [91] A. Odabaş, E.Ö. Uslu, and E. Ilgaz. Isoclinism of crossed modules. *J. Symbolic Comput.*, 74:408–424, 2016.
- [92] Y. Ouyang, Q.-R. Wang, Z.-C. Gu, and Y. Qi. Computing classification of interacting fermionic symmetry-protected topological phases using topological invariants. *arXiv e-prints*, page arXiv:2005.06572, May 2020.
- [93] Nansen Petrosyan and Bartosz Putrycz. On cohomology of crystallographic groups with cyclic holonomy of split type. *J. Algebra*, 367:237–246, 2012.
- [94] Alexander D. Rahm. The homological torsion of  $\mathrm{PSL}_2$  of the imaginary quadratic integers. *Trans. Amer. Math. Soc.*, 365(3):1603–1635, 2013.
- [95] Alexander D. Rahm. Accessing the cohomology of discrete groups above their virtual cohomological dimension. *J. Algebra*, 404:152–175, 2014.

- [96] Alexander D. Rahm. The subgroup measuring the defect of the abelianization of  $\mathrm{SL}_2(\mathbb{Z}[i])$ . *J. Homotopy Relat. Struct.*, 9(2):257–262, 2014.
- [97] Pradeep K. Rai and Manoj K. Yadav. On Sh-rigidity of groups of order  $p^6$ . *J. Algebra*, 428:26–42, 2015.
- [98] J. Roberts. *ALGORITHMS FOR UPPER BOUNDS OF LOW DIMENSIONAL GROUP HOMOLOGY*. PhD thesis, University of Kentucky. University of Kentucky, 2010.
- [99] Joshua Roberts. An algorithm for low dimensional group homology. *Homology, Homotopy Appl.*, 12(1):27–37, 2010.
- [100] Marc Röder. Geometric algorithms for resolutions for Bieberbach groups. In *Computational group theory and the theory of groups, II*, volume 511 of *Contemp. Math.*, pages 167–178. Amer. Math. Soc., Providence, RI, 2010.
- [101] Ana Romero, Graham Ellis, and Julio Rubio. Interoperating between computer algebra systems: Computing homology of groups with kenzo and gap. In *Proceedings of the 2009 International Symposium on Symbolic and Algebraic Computation*, ISSAC '09, pages 303–310, New York, NY, USA, 2009. ACM.
- [102] Ana Romero and Julio Rubio. Computing the homology of groups: the geometric way. *J. Symbolic Comput.*, 47(7):752–770, 2012.
- [103] Ana Romero and Julio Rubio. Homotopy groups of suspended classifying spaces: an experimental approach. *Math. Comp.*, 82(284):2237–2244, 2013.
- [104] Peter Schauenburg. Erratum to: “A higher Frobenius-Schur indicator formula for group-theoretical fusion categories”. *Commun. Math. Phys.*, 350(2):893–896, 2017.
- [105] S. Schönnenbeck. Homologiegruppen von Einheitengruppen von Ordnungen. *Masterarbeit, RWTH Aachen*, September 2013.
- [106] S. Schönnenbeck. Hecke operators for algebraic modular forms. *Thesis, RWTH Aachen*, September 2016.
- [107] S. Schönnenbeck. Resolutions for unit groups of orders. *ArXiv e-prints*, September 2016.
- [108] M. Schwald. On the definition of irreducible holomorphic symplectic manifolds and their singular analogs. *arXiv e-prints*, page arXiv:2003.06004, Dec 2020.
- [109] Markus Szymik. The third Milgram–Priddy class lifts. *arxiv.org/pdf/1909.05064.pdf*, pages 1–6, 2019.



- [110] Bui Anh Tuan and Graham Ellis. The homology of  $SL_2(\mathbb{Z}[1/m])$  for small  $m$ . *J. Algebra*, 408:102–108, 2014.
- [111] Lukas Vokřínek. Algorithmic aspects of topological problems. *Habilitation thesis, Brno University*, 2017.
- [112] Wayne Zheng, Jia-Wei Mei, and Yang Qi. Classification and monte carlo study of symmetric  $Z_2$  spin liquids on the triangular lattice. *arXiv:1505.05351*, 2015.
- [113] V. Álvarez, J.A. Armario, M.D. Frau, and P. Real. A mathematica notebook for computing the homology of iterated products of groups. In Andres Iglesias and Nobuki Takayama, editors, *Mathematical Software - ICMS 2006*, volume 4151 of *Lecture Notes in Computer Science*, pages 47–57. Springer Berlin Heidelberg, 2006.