

Curriculum Vita (short form) of Sean Allen Broughton

Professor Emeritus, Department of Mathematics
Rose-Hulman Institute of Technology

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Personal Information, Education, and Professional Experience

Personal and Contact Information

Date of Birth: November 12, 1951, Windsor, Ontario, Canada.
Address: 6 Lenox Dr., Shrewsbury, MA, 01545
Email: <mailto:brought@rose-hulman.edu>
Websites
Emeritus Website: <https://askthedoctorofmath.com/>
Rose Faculty Website: <https://wordpress.rose-hulman.edu/brought/>
Selected Works: https://works.bepress.com/allen_broughton/
Tilings of Surfaces Website: <https://tilings.org/>
Autosurf Website: <https://www.rose-hulman.edu/mapub/autosurf/home.html>

Education

B.Sc. (1975) University of Windsor, Ontario, Canada, 1971-73 & 1974-1975
Major in mathematics, minor in physics
M.Sc. (1978) Queen's University, Kingston, Ontario, 1975-78
Supervisor: O. A. Nielsen
Thesis Title: *The fundamental groups and centres of Lie groups*
Ph.D. (1982) Queen's University, 1978-82
Supervisor: A. J. Coleman
Thesis Title: *On the topology of polynomial hypersurfaces*
Languages Some fluency in spoken and written French
Reading knowledge of German

Work Experience (reverse chronological order)

2017-present	Professor Emeritus of Mathematics, Rose-Hulman Institute of Technology
2014-17	Professor of Mathematics, Rose-Hulman Institute of Technology
1994-2014	Professor and Head of Mathematics, Rose-Hulman Institute of Technology
1989-94	Associate Professor, Mathematics, Cleveland State University,
1986-89	Assistant Professor, Mathematics, Cleveland State University
1983-86	Van Vleck Visiting Assistant Professor, Mathematics, University of Wisconsin-Madison, (half-time, 9-83 to 9-85 while NSERC Postdoctoral Fellowship (Canada) concurrently held)
1981-83	Assistant Professor, Mathematics, Memorial University of Newfoundland
1975-80	Grader, Teaching Assistant, and Lecturer while a graduate student at Queen's University
1974-75	Sublieutenant, Canadian Armed Forces
1971-73, 74-75	Grader and Teaching Assistant, Mathematics, University of Windsor

Grants Awarded

1998-2001	Computational Group Theory and Hyperbolic Geometry, NSF-REU, DMS-9619714 (extension), \$120,000, P.I.
2001-2003	Computational Group Theory, Hyperbolic Geometry, Number Theory, and Inverse problems NSF-REU, DMS-0097804, \$144,000, P.I
2003-2004	Sophomore Course and Ancillaries in Nanoscience DMR-0304487 \$100,000 senior investigator
2003-2004	MAA Conference Grant supported by NSF DMS-0241090, \$2,000
2006-2007	MAA Conference Grant supported by NSF DMS-0536991, \$2,000
2014-2017	Rose Summer Undergraduate Research Program - grant administrator, \$60,000

Other Professional Activities

Spring 2001-02	Sabbatical, Mount Holyoke College
Spring 2007	Session on Automorphisms of Surfaces, U. of Arizona, Tucson, co-organizer
Spring 2007-08	Sabbatical, Indiana University
Spring 2007-08	visiting scholar, Universidad Nacional de Educacion a Distancia, Madrid Spain
Fall 2009	Session on Automorphisms of Surfaces, Penn State, co-organizer

Summer 2011	MAA PREP Workshop, Biomathematics - beyond Calculus, Sweet Briar College, participant
Winter 2012	MAA Joint Meetings Minicourse - Computational Discrete Geometry, Boston, participant
Winter 2013	MAA Joint Meetings Minicourse - Using Webwork, San Diego, participant
Summer 2013	Riemann and Klein Surfaces, Symmetries and Moduli Spaces, Linköping Sweden Member of Scientific Committee and Proceedings Associate Editor
Winter 2015	AMS Joint Meetings Short Course - Finite Frame Theory, participant
Fall 2015	Session on Automorphisms of Surfaces, Loyola University, co-organizer
Spring 2016	Sabbatical, Linköping University, Sweden and UNED, Madrid, Spain
Fall 2017	Symmetries of Surfaces, Maps and Dessins - BIRS - workshop leader
Spring 2018	Session on Automorphisms of Surfaces, Portland State University, co-organizer
2020	Contemporary Mathematics volume - in process, co-editor

Professional Societies,

1986-present	member, AMS, American Mathematical Society
1986-2018	member, MAA, Mathematical Association of America
1994-present	member, SIAM, Society for the Industrial Applications of Mathematics

Public Service

2011-17	Terre Foods Cooperative, Recruiting and Communications Committees
2018-19	Southgate at Shrewsbury, Resident Council - committee member
2018-	Massachusetts Life Care Residents' Association - Board member and consultant

Teaching Experience

Undergraduate Courses Taught

- College Algebra, Liberal Arts Mathematics, Mathematics for Teachers
- Basic and Pascal Programming
- all levels of Calculus
- Linear Algebra, Differential Equations, Statistics
- Discrete Mathematics, Probability
- Mathematical Modeling
- Euclidean, Non-Euclidean, and Differential Geometry
- Mathematics of Image Processing.
- Introduction to Parallel Computing
- Fractals and Chaotic Systems
- Lie Groups and Lie Algebras

Graduate Courses Taught

- Applied Linear Algebra
- Stochastic Methods of Operations Research
- Euclidean and Non-Euclidean Geometry
- Fractals and Chaotic Systems
- Lie Groups and Lie Algebras
- Algebraic Geometry

Research Interests and Computing Activities

Research Interests

- Riemann surfaces, non-Euclidean geometry, automorphisms, tilings, group actions, moduli and Teichmüller spaces
- Lie theory, geometry and topology of manifolds and homogeneous spaces
- singularity theory, algebraic geometry
- mathematics of image and signal processing, wavelets and frames

Computing Software and Systems

- *Computer Algebra Systems:* MAPLE, MATLAB, MAGMA, MACAULAY, GAP, MATHEMATICA
- *Programming Languages:* Python, C, FORTRAN, BASIC, PASCAL
- *Other:* TeX, standard productivity tools , HTML, PHP, Constant Contact

Computing Experience and Activities

- Extensive classroom use at Cleveland State and Rose-Hulman
- Extensive research use at Cleveland State and Rose-Hulman
- Webmaster and web site developer, RHIT Mathematics Department until August, 2014
- WeBWorK administrator, RHIT Mathematics Department
- Volunteer: Constant Contact email support for Terre Foods
- Volunteer/consultant: Webmaster, Digital archivist and Constant Contact email support for MLCRA

Publications and Presentations

For complete documentation and downloads of some works visit my BEpress Selected Works website: https://works.bepress.com/allen_broughton/

Theses

- T1. *The fundamental groups and centres of Lie groups*, Queen's University, M.Sc. Thesis, 1978.
- T2. *On the topology of polynomial hypersurfaces*, Queen's University, Ph.D. Thesis, 1982.

Books and Book Chapters

- B1. *The Science of Nanotechnology: An Introductory Text*, with L. Tilstra, R. Tanke, D. Jelski, V. French, G. Zhang, A. Popov, T. George, and A. Western, Nova Science Publishers, Hauppauge NY (2007).
- B2. *Discrete Fourier Analysis and Wavelets: Applications to Signal and Image Processing*, with Kurt Bryan, Wiley Interscience 2009.
- B3. *Discrete Fourier Analysis and Wavelets: Applications to Signal and Image Processing, Edition 2*, with Kurt Bryan, Wiley 2018.

Published / Accepted Papers

- P1. *A comment on unions of sigma-fields*, with B.W. Huff, Amer. Math. Monthly, **84** (7) (1977), 553-554.
- P2. *On the topology of polynomial hypersurfaces*, Proc. Symposia Pure Math., **40**, Amer. Math. Soc. (1983), 167-178.
- P3. *The height of two-dimensional cohomology classes of complex flag manifolds*, with M. Hoffman and W. Homer, Canadian Bull. Math. **26** (4) (1983), 498-502.
- P4. *A note on characters of algebraic groups*, Proc. of the AMS **89** (1) (1983), 39-40.
- P5. *The homology and higher representations of the automorphism group of a Riemann surface*, Transactions AMS **300** (1) (1987), 153-158.
- P6. *Volumes of subgroups of compact Lie groups*, Algebras, Groups and Geometries, **4** (1987), 325-364.
- P7. *Milnor numbers and the topology of polynomial hypersurfaces*, Invent. Math., **92** (1988), 217-241.
- P8. *The equisymmetric stratification of the moduli space and the Krull dimension of the mapping class group*, Topology and its Applications, **37** (1990), 101-113.
- P9. *Classifying finite group actions on surfaces of low genus*, J. of Pure & Appl. Algebra, **69** (1990), 233-270.
- P10. *The Gottlieb group of finite linear quotients of odd-dimensional spheres*, Proc. of the A.M.S., **111** (4) (1991), 1195-1197.

- P11. *Normalizers and centralizers of elementary Abelian subgroups of the mapping class group*, Topology '90, Walter de Gruyter, New York (1992), 77-89.
- P12. *Simple group actions on hyperbolic surfaces of least area*, Pacific J. of Math., **158** (1) (1993), 23-48.
- P13. *Symmetries of Riemann surfaces on which $PSL(2, q)$ acts as a Hurwitz automorphism group*, with E. Bujalance, A.F. Costa, J.M. Gamboa, and G. Gromadski, J. of Pure and Appl. Algebra. **106** (1996), 113-126, <https://www.sciencedirect.com/science/article/pii/0022404994000654>.
- P14. *Symmetries of Accola - Maclachlan and Kulkarni surfaces*, with E. Bujalance, A.F. Costa, J.M. Gamboa, and G. Gromadski, Proc. of the AMS. **127** #3 (1999), 637-646, <https://www.jstor.org/stable/118994>.
- P15. *Constructing Kaleidoscopic Tiling Polygons in the Hyperbolic Plane*, American Mathematical Monthly, **107** #8 (2000), 689-710, <https://www.jstor.org/stable/2695467>.
- P16. *Divisible tilings of the hyperbolic plane*, with D.M. Haney, L. McKeough and B. Smith, New York Journal of Mathematics, **6** (2000), 237-283, <http://nyjm.albany.edu:8000/j/2000/6-12.pdf>.
- P17. *Anharmonic Vibrational Motions in C_{60} : A Potential Energy Surface Derived from Vibrational Self Consistent Field Calculations*, with Daniel Jelski and Laszlo Nemes, Journal of Cluster Science, **16** (1) (2005).
- P18. *Finite Abelian Subgroups of the Mapping Class Group*, with Aaron Wootton, Algebraic & Geometric Topology, **7** (2007), 1651-1697. <http://msp.warwick.ac.uk/agt/2007/07/p066.xhtml>.
- P19. *Topologically Unique Maximal Elementary Abelian Group Actions on Compact Oriented Surfaces*, with Aaron Wootton, Journal of Pure and Applied Algebra, **213** (2009), 557-572, <https://www.sciencedirect.com/science/article/pii/S0022404908001692>.
- P20. *Cyclic n -gonal surfaces and their automorphism groups: two talks in the UNED Geometry Seminar*, with Aaron Wootton, Disertaciones del Seminario de Matematicas Fundamentales, no. 44, UNED, <https://arxiv.org/abs/1003.3262>.
- P21. *Ellipses in Translation Surfaces*, with Chris Judge, Geometriae Dedicata, (2012), 1-41, <https://doi.org/10.1007/s10711-011-9602-3>.
- P22. *Superelliptic surfaces as p -gonal surfaces*, Riemann and Klein Surfaces, Automorphisms, Symmetries and Moduli Spaces, Contemporary Mathematics Series #629, Amer Math Soc (2014), 15-28, <http://www.ams.org/books/conm/629/>.
- P23. *Exceptional automorphisms of (generalized) super elliptic surfaces*, with Aaron Wootton, Riemann and Klein Surfaces, Automorphisms, Symmetries and Moduli Spaces, Contemporary Mathematics Series #629, Amer Math Soc (2014), 29-42, <http://www.ams.org/books/conm/629/>.
- P24. *Quasi-platonic $PSL(2, q)$ -actions on closed Riemann surfaces*, Albanian Journal of Mathematics **9** (1), (2015), 31-61, <http://albanian-j-math.com/archives/2015-02.pdf>.
- P25. *Using Strong Branching to Find Automorphisms of n -gonal Surfaces*, with C. Camacho, J. Paulhus, R. Winarski, and A. Wootton, Albanian Journal of Mathematics **12** (1), (2019), 89-129, <https://albanian-j-math.com/archives/2018-08.pdf>.
- P26. *Galois action on regular dessins d'enfant with simple group action*, Higher Genus Curves in Mathematical Physics and Arithmetic Geometry, Contemporary Mathematics Series #703, Amer Math Soc (2018), 13-32, <http://www.ams.org/books/conm/703/>.

- P27. *On Automorphisms of Algebraic Curves*, with T. Shaska and A. Wootton, Algebraic Curves and Their Applications, Contemporary Mathematics Series #724, Amer Math Soc (2019), <https://www.ams.org/books/conm/724/>.
- P28. *Equivalence of finite group actions on Riemann surfaces and algebraic curves*, Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics, Contemporary Mathematics Series, (2021), accepted.
- P29. *Future directions in automorphisms of surfaces, graphs, and other related topics*, with Jennifer Paulhus and Aaron Wootton, Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics, Contemporary Mathematics Series, (2021), accepted.
- P30. *One dimensional equisymmetric strata in moduli space, with Antonio F. Costa and Milagros Izquierdo*, Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics, Contemporary Mathematics Series, (2021), accepted.
- P31. *The engaging symmetry of Riemann surfaces: a historical perspective*, with Gareth A. Jones and David Singerman, Automorphisms of Riemann surfaces, subgroups of mapping class groups and related topics, Contemporary Mathematics Series, (2021), accepted.

Technical Reports and Preprints

- TR1. *Symmetries of Accola-MacLachlan and Kulkarni Surfaces*, with E. Bujalance, A F. Costa, J.M. Gamboa, and G. Gromadzki, RHIT MSTR 95-05, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/64/.
- TR2. *Counting Ovals on a Symmetric Riemann Surface*, RHIT MSTR 97-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/68/.
- TR3. *Constructing Kaleidoscopic Tiling Polygons in the Hyperbolic Plane*, RHIT MSTR 98-06, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/112/.
- TR4. *Divisible Tilings in the Hyperbolic Plane*, with Dawn M. Haney, Lori T. McKeough, and Brandy M. Smith, MSTR 99-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/60/.
- TR5. *Splitting tiled surfaces with abelian conformal tiling group*, RHIT MSTR 99-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/58/.
- TR6. *Triangular Surface Tiling Groups for Low Genus*: with Robert M. Dirks, Maria T. Sloughter, and C. Ryan Vinroot, RHIT MSTR 01-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/55/.
- TR7. *The Birational Isomorphism Types of Smooth Real Elliptic Curves*, RHIT MSTR 04-05, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/44/.
- TR8. *The Barycenter of the Numerical Range of a Matrix*, with Roger Lautzenheiser and Thomas Werne, RHIT MSTR 07-04, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/39/.
- TR9. *Flattening a Cone*, RHIT MSTR 09-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/16/.
- TR10. *Calculation of the Killing Form of a Simple Lie Group*, RHIT MSTR 14-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/38/.

- TR11. *Analytical Solution of the Symmetric Circulant Tridiagonal Linear System*, with J.J. Leader, RHIT MSTR 14-02, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/103/.
- TR12. *Continuous Dependence of Solutions of Equations on Parameters*, RHIT MSTR 14-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/107/.
- TR13. *Quasi-platonic $PSL_2(q)$ -actions on closed Riemann surfaces*, RHIT MSTR 15-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/151/.
- TR14. *Topological and H^q Equivalence of Prime Cyclic p -gonal Actions on Riemann Surfaces (Corrected)*, RHIT MSTR 16-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/155/.
- TR15. *Branching Matrices for the Automorphism Group Lattice of a Riemann Surface*, RHIT MSTR 18-01, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/167/.
- TR16. *Topological and H^q Equivalence of Cyclic n -gonal Actions on Riemann Surfaces - Part II*, RHIT MSTR 20-03, Rose-Hulman Math. Sci.Tech. Report Series, https://scholar.rose-hulman.edu/math_mstr/175/.

Presentations (1999 - present)

1. *Tilings, finite groups, and hyperbolic geometry at the Rose-Hulman REU*, Kanazawa Institute of Technology, July 1999, invited lecture.
2. *Higher genus Soccer Balls and Kaleidoscopic Tilings in the Hyperbolic Plane*, Rose Mathematics Seminar, April 2000, two contributed lectures.
3. *The Unreasonable Effectiveness of Mathematics*, Rose-Hulman Symposium to open 126'th school year, August 2000, invited presentation.
4. *Transform Methods in Image Processing*, Mathematics Faculty Seminar, Mount Holyoke College, Spring 2001, invited lecture series.
5. *Higher Genus Soccer Balls*, Mount Holyoke Math Club, Spring 2001, invited presentation.
6. *Signals, Images, ..., What's Next in Scientific Visualization*, Sigma Xi, Mount Holyoke College, Spring 2001, invited presentation.
7. *The Rose-Hulman Laptop Program*, with Ed Doering, Ohio Northern University, September 2001, invited presentation.
8. *Automorphisms of Riemann Surfaces, Galois Groups, and Hecke Algebras*, Rose Math Seminar, March 2002, contributed lecture.
9. *Vanishing Cycles and Kaleidoscopic Quadrilateral Tilings*, Rose Math Seminar, December 2002, contributed lecture.
10. *Kaleidoscopic Tilings on Surfaces, This Time with the Groups*, Rose Math Seminar, Spring 2003, two contributed lectures.
11. *Are the Students Competent Users of Mathematics?*, AMS Annual Meeting, Phoenix, January, 2004, contributed talk.

12. *Equivalence of Real Elliptic Curves*, Rose Math Seminar, October 2004, two contributed lectures.
13. *Fostering Undergraduate Research in Mathematics*, Showcase - Best Assessment Practices VII, Rose-Hulman, April 2005, contributed presentation.
14. *Enumeration of the Equisymmetric Strata of the Moduli Space of Surfaces of Low Genus*, AMS Regional Conference, Santa Barbara, April 2005 invited talk.
15. *Higher Genus Soccer Balls*, ISU Math Seminar, Fall 2006, invited presentation.
16. *Geometry from Chemistry*, Rose Math Seminar, Fall 2006, two contributed lectures.
17. *Geometry from Chemistry*, INMAA Spring Meeting, 2007, contributed talk.
18. *Classifying Pairs of Fuchsian Groups of Finite Type*, AMS Regional Conference, Tucson, April 2007, invited talk.
19. *Elementary Abelian Group Actions on Surfaces and the Geometry of Moduli Space*, IU Geometry Seminar, November, 2007, invited lecture.
20. *The Barycenter of the Numerical Range of an Operator*, ISU Math and CS Research Seminar, November 28, 2007, invited lecture.
21. *Billiards and Flat Surfaces, Voronoi Tesselations, Delaunay Tesselations and Flat Surfaces*, Rose Math Seminar, Fall 2008, two contributed lectures.
22. *Full Automorphism Groups of Cyclic n -gonal Surfaces*, First of two talks in the UNED Geometry Seminar, February 2009, invited presentation.
23. *Classification of Pairs of Fuchsian Groups*, Second of two talks in the UNED Geometry Seminar, March 2009, invited presentation.
24. *Cyclic n -gonal surfaces - weakly malnormal actions and computational methods*, joint with Aaron Wootton, 25th Nordic and 1st British-Nordic Congress of Mathematicians, June 2009, invited talk.
25. *Roll-ups and Differential Geometry*, Rose Math Seminar, Fall 2009, contributed lecture.
26. *Roll-ups and Differential Geometry*, INMAA section meeting, Fall 2009, contributed talk.
27. *Flat Surfaces, Teichmueller Discs, Veech Groups, and the Veech Tessellation*, AMS Regional Conference, Pennsylvania State University, University Park, PA, October 2009, invited talk.
28. *Galois actions on regular dessins and Fuchsian group covers*, Conference on Riemann Surfaces and Dessins d'Enfants On the Occasion of Jürgen Wolfart's 65'th Birthday, May 2010, invited talk.
29. *Who painted this Painting?* Rose Math Seminar, Spring 2012, contributed lecture.
30. *Pairs of Pants and the Congruence Laws of Geometry*, Rose Math Seminar, Spring 2013, contributed lecture.
31. *Exceptional Automorphisms of (Generalized) Super-elliptic Curves*, Riemann and Klein Surfaces, Symmetries and Moduli Spaces, Linköping Sweden, June 2013, invited talk.
32. *Framing the Image*, Rose Math Seminar, February 2015, contributed lecture.
33. *Quasi-platonic actions of $PSL_2(q)$ and their Dessins*, AMS Regional Conference, Michigan State University, East Lansing MI, March 2015, invited talk.

34. *Symmetric surfaces with quasi-platonic $PSL(2, q)$ action*, AMS Regional Conference, Loyola University, Chicago IL, October 2015, invited talk.
35. *Quasi-platonic actions of some simple groups on Riemann surfaces and their dessins d'enfant*, Joint Mathematics Meetings, Seattle, WA, January 2016, invited talk.
36. *Riemann Surfaces: A playground for analysis, topology, geometry, group theory, and Galois theory*, MAI seminar, Linköping University, March 2016, invited lecture.
37. *Moduli space - Geometry/Math with Letters*, Rose Math Seminar, Fall 2016, contributed lecture.
38. *Scientific Visualization and Trigonometry: Do They Mix?* New College of Florida Data Science Seminar, Sarasota FL, October 2016, invited lecture.
39. *Subgroups of the Mapping Class Group Corresponding to 1-Dimensional Strata in the Branch Locus of Moduli Space*, with A. Costa and M. Izquierdo, AMS Annual Meeting, Atlanta GA, January, 2017, invited talk.
40. *Sabbatical Travelogue: Sweden, Spain, and China*, RHIT Global Studies Faculty Seminar, May 2017, invited presentation.
41. *Defining Equations for Riemann Surfaces, BIRS Workshop on Symmetries of Surfaces, Maps and Dessins*, Banf, Alberta, September 2017, contributed lecture.
42. *Topological and \mathcal{H}^q Equivalence of Prime Cyclic p -gonal Actions on Riemann Surfaces*, AMS Regional Conference, Portland State University, Portland OR, April 2018, invited talk.
43. *Signals, Bases of Waveforms, and Frames*, College of the Holy Cross Faculty Seminar, Worcester, MA April 2019, invited lecture.