TIM D. COCHRAN

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Education

PhD University of California, Berkeley, 1982
MA University of California, Berkeley, 1979
BS Massachusetts Institute of Technology, 1977

Areas of Research

Topology, especially topology of 3- and 4-dimensional manifolds, theory of knots and links and associated group theory

Fellowships and Honors

Faculty Teaching and Mentoring Award, Rice Graduate Student Association 2014
Simons Fellow in Mathematics (2014–2015)
Fellow of American Mathematical Society (2014–)
Research Professorship, MSRI, Berkeley, 1996–97
NSF Postdoctoral Fellowship, 1985–87
Postdoctoral Fellowship, MSRI, 1984–85
U.Calif. Regents Graduate Fellow, 1977–78

Professional Appointments

Professor, Rice University, 1998–
Research Professor, M.S.R.I., Berkeley, Ca., 1996–97
Associate Professor, Rice University, 1990–98
Visiting Assistant Professor, Northwestern Univ., 1988–90
Visiting Assistant Professor, U.C. Berkeley, 1987–88
C.L.E. Moore Postdoctoral Instructor, Massachusetts Institute of Technology, 1982–84

Departmental Activities

Career Mentor for Andrew Putman, Assistant Professor, 2011-2013
Teaching Mentor for Anthony Varilly-Alvarado, Assistant Professor, 2011-present
Career Mentor for Allison Moore, 2013-present
Teaching Mentor for Ina Petkova, G.C. Evans Instructor, 2012-2015
Teaching Mentor for Betul Orcan, G.C. Evans Instructor, 2011-2014
Research Mentor for Danielle O'Donnol, G.C. Evans Instructor, 2008-2011
Research Mentor for Elena Pavalescu, G.C. Evans Instructor, 2008-2011
Research and Teaching Mentor for Maggie Tomova, G.C. Evans Instructor, 2007-2008
Teaching Mentor for Kelly McKinnie, NSF Postdoctoral Fellow/Evans Instructor, 2007–2009
Teaching Mentor for Keiko Kawamuro, G.C. Evans Instructor, 2006-2008
Graduate Committee, chair 1997–2007, member 1992-1996, 1997-2014.
Undergraduate Committee, chair 2012-2014, member 2005–2014
Undergraduate Advisor (approximately 20 students), 2004–present
Research Advisor for MA and PhD students, 5 current (17 since 1990)

Appointments Committee, chair 1999, member 2003,2009,2011-present; co-chair, 2005, 2007, 2008
Mathematics Department Computer Committee Chair, 1991–96
Organizer of 2 Undergraduate Conferences, 2002,2000.
Co-organizer of Topology Seminar
Co-organizer of VIGRE working topology seminar

Service to the University

Orientation Week advisor, yearly
Undergraduate Advisor (approximately 20 students), 2004–present
Curriculum Committee of the Wiess School of Natural Sciences, 1997-2006
Sponsor of Undergraduate Mathematics Conference, Rice University, March 2001,2003
Planning Committee for the Center for Teaching and Curricular Innovation, 2000
Faculty Associate of Wiess College, 1990–2001
Outstanding Faculty Associate, 1992–93
Rice University Admissions Committee, 1991–94

Thesis Supervision (Ph.D. unless noted)

16. Arunima Ray, 2014, "Casson towers and filtrations of the smooth knot concordance group"
15. Christopher Davis, 2012, "First Order Invariants and Linear Independence in the Concordance Group"
14. Bridget Franklin, 2012, "The Effect of Infecting Curves on Knot Concordance".
13. Andrew Elliott, December 2009 "State Cycles, Quasipositive Modification and Constructing H-thick Knots in Khovanov Homology"
12. Peter Horn, 2009 , "Higher-order Analogues of Genus and Slice Genus of Classical Knots," National Science Foundation Postdoctoral Fellow.
11. Jamie Jorgensen, 2008, "Surface Homeomorphisms That Do Not Extend to Any Handlebody and the Johnson Filtration,"
10. Connie Leidy, 2004, "Higher-order linking forms for 3-manifolds,"
9. Aaron Heap, 2004, "Bordism Invariants of the mapping class group,"
8. Carol Gwosdz Gee, 2004, "S-equivalence of links,"
7. Steven Wallace, M.A. 2004, "Knots and Quandles,"
6. Shelly Harvey, 2002, "Higher-order polynomial invariants of 3-manifolds giving lower bounds for Thurston's norm," NSF Postdoctoral Fellow.
5. Amy Noel Lampazzi, 2001, "Divisibility of the Conway Polynomial of Links," (awarded NSF-GK12 Fellowship)
4. Amir Gerges, December 1996, "On 3-manifolds equivalent by homologically trivial surgeries,"
3. Paul Bellis, 1996, "Homology Boundary Links, Patterns, and Seifert Forms,"
2. Simrat Ghuman, 1996, "Invariants of Graphs,"
1. Serguei A. Sirotine, 1995, "Approximation of Knot Invariants by Vassiliev Invariants."

additional current PhD students: 5; second reader on 3 other PhD theses in the past 4 years.

Research Grants

National Science Foundation:
DMS - 1309081 "Knot theory: 3- and 4-dimensional manifolds", (PI), 6/2013–6/2016

DMS - 1308209 "3-Manifolds: Heegaard Splittings, the Curve Complex, and Hyperbolic Geometry", (co-PI), 2/2013–2/2014

DMS 1148609 "RTG: Analysis, Geometry, and Topology", (co-PI), 8/2013–7/2017

DMS-1006908 "Noncommutative Algebraic Invariants in Topology", (PI), 7/10–7/13

DMS-0706929 "Noncommutativity in Low-Dimensional Topology", (PI), 7/07–7/10

DMS-0406573 "Noncommutative algebraic invariants in low-dimensional topology", (PI), 5/04–7/07

DMS-0104275 "Noncommutative algebraic phenomena in the topology of 3 and 4-dimensional, spaces", (PI), 6/01–7/04

DMS-9803694 "Knotting and Linking Phenomena in Topology," (PI), 6/15/98–6/15/01

DMS-9626565 "SCREMS" Rice Univ., (PI), 6/1/96–5/31/99

DMS-9400224 "Knotting Phenomena in Topology," (PI), Rice Univ., 12/31/94–12/31/97

DMS-9205540 "Computation in Geometry, Topology and Ergodic Theory," (PI), SCREMS Rice Univ.,
5/1/92–4/20/95

DMS-9100254 "Topology and Geometry of Manifolds," (PI), Rice Univ., 7/1/91–6/30/94

DMS-8903514 "Topology and Geometry of Manifolds," (PI), Northwestern Univ., 7/1/89–6/30/91

DMS-8841714 U. Calif. Berkeley, 7/1/88–6/30/89

DMS-8303241 M.I.T., 7/1/83–12/31/85

PUBLICATIONS

1. Slice links in S^4, *Trans. Amer. Math. Soc.* **285** (1983), 389–401.

2. Embedding 4-manifolds in S^5, *Topology* **23** no. 3 (1984), 257–269.

3. Four-manifolds which embed in $\mathbf{R}^6$ but not in $\mathbf{R}^5$ and Seifert manifolds for fibered knots, *Inventiones Math.* **77** (1984), 173–184

4. Ribbon knots in S^4, *Journal of London Math. Soc.* **28** (1984), 563–576.

5. On an invariant of link cobordism in dimension 4, *Topology and its Appl.* **18** (1984), 97–108.

6. A topological proof of Stallings' theorem on lower central series of groups, *Math. Proc. Camb. Phil. Soc.* **97** (1985), 465–472.

7. Geometric invariants of link cobordism, *Commentarii Math. Helvetii* **60** (1985), 291–311.

8. Concordance invariance of coefficients of Conway's link polynomial, *Inventiones Math.* **82** (1985), 527–541.

9. Unknotting information from 4-manifolds (with W.B.R. Lickorish), *Trans. Amer. Math. Soc.* **297:1** (1986), 125–142.

10. Link concordance invariants and homotopy theory, *Inventiones Math.* **90** (1987), 635–645.

11. Applications of Donaldson's 4-manifold theorems to classical knot theory, homology 3-spheres and Property P (with R.E. Gompf), *Topology* **27** (1988), 495–512.

12. Invariants of tangles (with D. Ruberman), *Math. Proc. Cambridge Phil. Soc.* **105** (1989), 299–306.

13. Localization and finiteness in link concordance, *Topology and its Applications* **32** (1989), 121–133.

14. Derivatives of links: Massey products and Milnor's concordance invariants, *Memoirs of Amer. Math. Soc.* **84** no. 427 (1990)

15. On the homotopy theory of simply-connected 4-manifolds (with N. Habegger), *Topology* **29** (1990).

16. Links with trivial Alexander Module but non-vanishing Massey products, *Topology* **29** (1990), 189–204.

17. Not all links are concordant to boundary links (with K.E. Orr), *Bulletin of American Math. Soc.* **23** (1990), 99–106.

18. Homology boundary links and the Andrews-Curtis conjecture (with J. Levine), *Topology* **30** (1991), 231–240.

19. K-cobordism for links in S^3, *Transactions of A.M.S.* **327** (1991) 641–654.

20. Classical link invariants and the Hawaiian earrings space, *Journal of Knot Theory and its Ramifications*, **Vol 1, No. 4** (1992).

21. Not all links are concordant to boundary links (with K.E. Orr), *Annals of Mathematics* **138** (1993), 519–554.

22. Homology boundary links and Blanchfield forms: Concordance classification and new tangle-theoretic constructions (with K.E. Orr), *Topology* **33**, no. 3 (1994), 397–427.

23. Non-trivial links and Plats with trivial Gassner matrices, *Proc. Cambridge Philosophical Soc.* **119**, no. 43 (1996), 43–53.

24. Stability of Lower Central Series of Compact 3-manifold Groups (with K.E. Orr), *Topology* **37**, no. 3 (1998), 497–526.

25. Homology Cobordism and Generalizations of Milnors Invariants, *Journal of Knot Theory and its Ramifications* **8**, no. 4 (1999), 429–436.

26. Finite Type Invariants of 3-manifolds (with Paul Melvin), *Inventiones Math.* **140** (2000), 45–100.

27. Dehn Surgery Equivalence Relations on 3-Manifolds (with Amir Gerges and K.E. Orr), *Math. Proc. of Cambridge Phil. Soc* **131** (2001), 97–127.

28. Quantum Cyclotomic Orders of 3-manifolds (with Paul Melvin), *Topology* **40** (2001), 96–125.

29. Knot Concordance, Whitney Towers and L^2-signatures (with Kent Orr and Peter Teichner), *Annals of Math.* **157** (2003), 433–519.

30. Structure in the Classical Knot Concordance Group (with K. Orr and P. Teichner), *Commentarii Mathematica* **79**, no. 1 (2004), 105–123.

31. Noncommutative Knot Theory, *Algebraic and Geometric Topology* **4** (2004), 347–398.

32. Homology and Derived Series of Groups (with Shelly Harvey), *Geometry and Topology, v.9,*(2005)2159-2191.

33. The Growth Rate of the First Betti Number of Abelian Covers of 3-Manifolds (with Joseph Masters), *Math.Proc.Cambridge Phil.Soc.*, **141** (2006), 465-476.

34. Knot Concordance and von Neumann rho invariants (with P. Teichner), *Duke Math. Journal*, **137**, no.2. (2007), 337–379.

35. Higher-Order Alexander Modules and Filtrations of the Knot Concordance Group (with Taehee Kim), *Trans.Amer.Math.Soc.*, *Trans. Amer. Math Soc*, 360 no.3 (2008)1407-1441.

36. Homology and Derived Series of Groups II: Dwyer's Theorem, (with Shelly Harvey), *Geometry and Topology,*12, (2008) 199-232.

37. Knot Concordance and Blanchfield Duality, (with Shelly Harvey and Constance Leidy), *Oberwolfach Reports*, **3**,3, (2006), 2154–2157.

38. Homology and derived p-series of Groups, (with Shelly Harvey), *Jour. London Math. Soc.*, 78, part3,(2008),677-692; doi: 10.1112/jlms/jdn046.

39. Link concordance and generalized doubling operators , (with Shelly Harvey and Constance Leidy), *Alg. Geom. Top.*,8(2008),1593-1646,DOI: 10.2140/agt.2008.8.1593.

40. New Constructions of Slice Links, (with Stefan Friedl and Peter Teichner), *Commentarii Math. Helv.*,83, no.3,(2009),617-638.

41. Knot Concordance and Higher-Order Blanchfield Duality, (with Shelly Harvey and Constance Leidy), *Geometry and Topology*, 13(2009),1419-1482.

42. Homological Stability of Series of Groups (with Shelly Harvey), *Pacific Math Journal*, 246, no.1,(2010)31-47.

43. Second order signatures and Derivatives of Knots, (with Shelly Harvey and Constance Leidy), *Alg. and Geometric Topology*, 10 (2010), 739-787, DOI: 10.2140/agt.2010.10.739.

44. The Milnor degree of a 3-manifold (with Paul Melvin), *Journal of Topology*, (2010)3(2):405-423.

45. 2-torsion in the n-solvable Filtration of the Knot Concordance group (with Shelly Harvey and Constance Leidy), *Proc. London Math.Soc.*, 102(2), (2011),257-290.

46. Primary decomposition and the fractal nature of knot concordance (with Shelly Harvey and Constance Leidy), *Math. Annalen*, 351 no.2, 2011, 443-508.

47. Higher-order signature cocycles for subgroups of mapping class groups and homology cylinders, (with Shelly Harvey and Peter Horn), *Int. Math. Res. Notices*, No. 14, 2012, 3311-3373.

48. Knot Concordance and Homology Cobordism (with Bridget Franklin, Matthew Hedden and Peter Horn), *Proc. Amer. Math Soc.*, 141 (2013), 2193-2208.

49. Homology cobordism and Seifert-fibered 3-manifolds (with Daniel Tanner),*Proc. Amer. Math. Soc.*, 142 (2014), 4015–4024.

50. Filtering smooth concordance classes of topologically slice knots (with Shelly Harvey and Peter Horn), *Geometry and Topology*, 17 (2013), 2103-2162.

51. Injectivity of satellite operations in knot concordance (with Christopher Davis and Arunima Ray), *Journal of Topology*, 7(2014), (4), 948-964, doi: 10.1112/jtopol/jtu003.

52. Positive Links, (with Eamonn Tweedy), *Alg. and Geometric Topology*, 14(2014), 2259-2298.

53. Structure in the bipolar filtration of topologically slice knots (with Peter Horn), *Alg. and Geometric Topology*, to appear, http://front.math.ucdavis.edu/1208.5788.

54. Counterexamples to Kauffman's conjectures on slice knots (with Christopher Davis), *Advances in Math.*, to appear, preprint http://front.math.ucdavis.edu/1303.4418.

55. The geometry of the knot concordance space, (with Shelly Harvey), submitted, preprint http://front.math.ucdavis.edu/1404.5076

Selected Invited and Plenary Lectures

1. Invited plenary lecture, Conference on Knots and Low-dimensional manifolds; satellite conference to ICM Seoul, August 2014.

2. Invited lecture, Georgia Tech Topology Conference, Dec. 2013

3. Invited lecture, Conference on the Topology and Invariants of smooth 4-dimensional manifolds, U. Minnesota, August 2013.

4. AMS Invited Address, AMS Sectional Meeting, Akron Ohio, October 2012.

5. Invited address, Knot Concordance and Homology Cobordism conference, Wesleyan University, with Shelly Harvey and Peter Horn, July 2010

6. Invited Address, Georgia International Topology Conference 2009, Athens, Georgia. , with Shelly Harvey (presenter), Constance Leidy, May, 2009.

7. Plenary Lecture: Low-Dimensional Topology, (Rob Kirbyfest), MSRI, with Shelly Harvey and Constance Leidy (presenter), August, 2008

8. Plenary Lecture Series: KAIST: Korean Institute for Advanced Science and Technology, Gyeongsangbuk-do, Korea. (June 29 - July 2, 2005) .

9. Plenary Lecture: Submanifolds, Singular Varieties and Stratified Spaces, (Julius Shanesonfest), Courant, March 16, 2005

10. Plenary Lecture: 3-Manifolds and Knot Theory (Cameron Gordonfest),, Austin, Texas, May 25, 2005

11. Invited Lecture on my work given at the ICM 2002 in Beijing by my coauthor Peter Teichner (also with Kent Orr), Knots, von Neumann signatures and grope cobordism, Proceedings of the International Congress of Math., Vol II: Invited Lectures, 437-446