John C. Baez

CONTACT INFORMATION	Department of Mathematics University of California Riverside, California 92521 USA	phone: +951-781-7172 fax: +951-827-1012 email: baez@math.ucr.edu web: http://math.ucr.edu/home/baez/

CITIZENSHIP   USA

EDUCATION
Ph.D., Mathematics, **Massachusetts Institute of Technology**, 1986.
Thesis: *Conformally Invariant Quantum Fields*. Advisor: Irving Segal.

- National Science Foundation Fellowship, 1982-1985.

B.A., Mathematics, **Princeton University**, 1982.
Thesis: *Recursivity in Quantum Mechanics*. Advisor: John Burgess.

EMPLOYMENT
University of California at Riverside, Department of Mathematics, and summers at the **Centre for Quantum Technologies**. Consultant for **Pyrofex Corporation**.

- On leave, visiting the **Centre for Quantum Technologies**, 2010-2012.
- Full Professor, **University of California at Riverside**, Department of Mathematics, 1995-2016.
- Associate Professor, 1991-1995.
- On leave, visiting **Wellesley College**, 1990-1992.
- Assistant Professor, 1988-1991.

Yale University, Department of Mathematics, Gibbs Instructor, 1986-1988.

COURSES TAUGHT
Applications of Mathematics without Calculus, First Year Calculus, Discrete Stuctures, Vector Calculus, Differential Equations, Linear Algebra, Game Theory, Number Theory, Advanced Calculus, Foundations of Mathematics, Mathematical Physics, Methods of Theoretical Physics, Graduate Real Analysis, Graduate Complex Analysis, Graduate Algebraic Topology, Quantum Theory and Analysis, Category Theory, Symbolic Computation, Low-Dimensional Topology and Physics, Knots and Quantum Gravity, Quantum Gravity Seminar, Geometric Representation Theory Seminar, Mathematics of the Environment.

SERVICE
Served as Ph.D. advisor for 14 students. Served on Executive Committee, Committee on Preparatory Education, Library Committee, faculty hiring committees in mathematics and physics, and other committees.

HONORS
1999, Elected Fellow of the American Association of Science.

2007, Elected Member of the Foundational Questions Institute.

2013, Levi L. Conant Prize for the best expository paper published in the *Notices* or *Bulletin* of the American Mathematical Society.

GRANTS	co-PI for 'n-Categories: Foundations and Applications' with Peter May, $50,000, Institute for Mathematics and its Applications, June 2004.
	PI for 'Feynman Diagrams and the Semantics of Quantum Computation', NSF program on Quantum Information and Revolutionary Computing, $148,938, August 2007 – August 2010.
	PI for 'Categorifying Fundamental Physics', Foundational Questions Institute, $131,865, August 2008 – August 2010.
	Subcontractor for Metron Scientific Solutions, 'Complex Adaptive System Composition and Design Environment', DARPA, $549,742, August 2016 – August 2019.
EDITORIAL BOARDS	Steering board, *Compositionality*
CONFERENCES ORGANIZED	Knots and Quantum Gravity workshop, U. C. Riverside, May 14–16, 1993.
	Knots and Quantum Gravity session of the Seventh Marcel Grossmann Meeting on General Relativity, Stanford, July 26, 1994.
	Low-dimensional Topology and Quantum Gravity session of Workshop on Canonical and Quantum Gravity II, Stephan Banach Institute, Warsaw, May 26 – June 6, 1997.
	Low-dimensional Topology and Quantum Gravity session of Joint Mathematics Meetings, Baltimore, January 7–8, 1998.
	n-Categories: Foundations and Applications, workshop at Institute for Mathematics and its Applications, Minneapolis, June 7–18, 2004.
	Higher Categories and Their Applications, workshop as part of the Thematic Program on Geometric Applications of Homotopy Theory, Fields Institute, Toronto, January 9–13, 2007.
	Category Theory at the Crossroads, Dagstuhl Perspectives Workshop, Dagstuhl, Germany, April 27-May 2, 2014.
	Information and Entropy in Biological Systems, National Institute of Mathematical and Biological Synthesis, Knoxville, April 8–10, 2015.
	Categorical Foundations of Network Theory, Institute of Scientific Interchange, Turin, May 25–28, 2015.
	Applied Category Theory, AMS Western Sectional Meeting, Riverside, November 24–25, 2018.
BOOKS	*An Introduction to Algebraic and Constructive Quantum Field Theory*, with Irving Segal and Zhengfang Zhou, Princeton University Press, 1992.
	Knots and Quantum Gravity, editor, Oxford University Press, 1994.
	Gauge Fields, Knots, and Gravity, with Javier Muniain, World Scientific Press, 1994.
	Infinite-Dimensional Representations of 2-Groups, with Aristide Baratin, Laurent Freidel and Derek Wise, Memoirs of the American Mathematical Society **1032**, Providence, Rhode Island, 2012.
	Quantum Techniques for Stochastic Mechanics, with Jacob Biamonte, World Scientific Press, Singapore, 2018.

PAPERS

1. Recursivity in quantum mechanics, *Trans. Amer. Math. Soc.* **280** (1983), 339-350.

2. Bell's inequality for C*-algebras, *Lett. Math. Phys.* **13** (1987), 135–136.

3. Is life improbable?, *Found. Phys.* **19** (1989), 91–95.

4. The global Goursat problem on $R \times S^1$, with Zhengfang Zhou, *Jour. Funct. Analysis* **83** (1989), 364–382.

5. Scattering and the geometry of the solution manifold of $\Box f + \lambda f^3 = 0$, *Jour. Funct. Analysis* **83** (1989), 317–332.

6. Analyticity of scattering for the ϕ^4 theory, with Zhengfang Zhou, *Comm. Math. Phys.* **124** (1989), 9–21.

7. Scattering for the Yang-Mills equations, *Trans. Amer. Math. Soc.* **315** (1989), 823–832.

8. Wick products of the free Bose field, *Jour. Funct. Analysis* **86** (1989), 211–225.

9. Scattering and complete integrability in conformally invariant nonlinear theories, *Jour. Math. Phys.* **31** (1990), 757–762.

10. The global Goursat problem and scattering for nonlinear wave equations, with Irving Segal and Zhengfang Zhou, *Jour. Funct. Analysis* **93** (1990), 239–269.

11. Conserved quantities for the Yang-Mills equations, *Adv. Math.* **82** (1990), 126–131.

12. Scattering and complete integrability in the massive ϕ^4 theory, with Zhengfang Zhou, *Jour. Funct. Analysis* **94** (1990), 397–414.

13. Topological lower bound on the energy of a twisted rod, with Rossen Dandoloff, *Phys. Lett. A* **155** (1991), 145–147.

14. The vacuum and lightcone quantization of interaction Hamiltonians, *Lett. Math. Phys.* **21** (1991), 117–121.

15. Differential calculi on quantum vector spaces with Hecke-type relations, *Lett. Math. Phys.* **23** (1991), 133–141.

16. Renormalized oscillator Hamiltonians, with Zhengfang Zhou, *Adv. Math.* **92** (1992), 106–127.

17. On quantum fields satisfying a given wave equation, with Zhengfang Zhou, *Jour. Funct. Analysis* **106** (1992), 439–453.

18. On the Hopf term in a 2-dimensional sigma model for antiferromagnets, with Alan Bishop and Rossen Dandoloff, *Mod. Phys. Lett. B* **5** (1991), 2003–2005.

19. R-commutative geometry and quantization of Poisson algebras, *Adv. Math.* **95** (1992), 61–91.

20. Scattering and complete integrability in four dimensions, in *Mathematical Aspects of Classical Field Theory,* eds. Mark Gotay, Jerrold Marsden and Vincent Moncrief, Contemp. Math. **132**, American Mathematical Society, Providence, Rhode Island, 1992, pp. 99–116.

21. Link invariants of finite type and perturbation theory, Lett. Math. Phys. **26** (1992), 43–51.

22. Quantum gravity and the algebra of tangles, *Class. Quantum Grav.* **10** (1993), 673–694.

23. An algebraic approach to discrete mechanics, with James Gilliam, *Lett. Math. Phys.* **31** (1994), 205–212.

24. Generalized measures in gauge theory, *Lett. Math. Phys.* **31** (1994), 213–223.

25. Diffeomorphism-invariant generalized measures on the space of connections modulo gauge transformations, in *Proceedings of the Conference on Quantum Topology*, ed. David N. Yetter, World Scientific Press, Singapore, 1994, pp. 21–43.

26. Strings, loops, knots and gauge fields, in *Knots and Quantum Gravity*, ed. J. Baez, Oxford U. Press, Oxford, 1994, pp. 133–168.

27. Hochschild homology in a braided tensor category, *Trans. Amer. Math. Soc.* **344** (1994), 885–906.

28. Strings and two-dimensional QCD for finite N, with Washington Taylor IV, *Nucl. Phys. B* **426** (1994), 53–70.

29. Link invariants, holonomy algebras and functional integration, *Jour. Funct. Analysis* **127** (1995), 108–131.

30. Topological aspects of spin and statistics of solitons in nonlinear sigma-models, with Michael Ody and William Richter, *Jour. Math. Phys.* **36** (1995), 108–131.

31. Higher-dimensional algebra and topological quantum field theory, with James Dolan, *Jour. Math. Phys.* **36** (1995), 6073–6105.

32. Quantum gravity hamiltonian for manifolds with boundary, with Javier P. Muniain and Dardo Píriz, *Phys. Rev. D* **52** (1995), 6840–6845.

33. Spin networks in gauge theory, *Adv. Math.* **117** (1996), 253–272.

34. Spin networks in nonperturbative quantum gravity, in *The Interface of Knots and Physics*, ed. Louis Kauffman, American Mathematical Society, Providence, Rhode Island, 1996, pp. 167–203.

35. Four-dimensional BF theory as a topological quantum field theory, *Lett. Math. Phys.* **38** (1996), 129–143.

36. Knots and quantum gravity: progress and prospects, in *Proceedings of the Seventh Marcel Grossman Meeting on General Relativity*, ed. Robert T. Jantzen and G. Mac Keiser, World Scientific Press, Singapore, 1996, pp. 779–797.

37. Higher-dimensional algebra I: braided monoidal 2-categories, with Martin Neuchl, *Adv. Math.* **121** (1996), 196–244.

38. An introduction to n-categories, *7th Conference on Category Theory and Computer Science,* eds. Eugenio Moggi and Giuseppe Rosolini, Lecture Notes in Computer Science vol. 1290, Springer, Berlin, 1997, pp. 1–33.

39. Higher-dimensional algebra II: 2-Hilbert spaces, *Adv. Math.* **127** (1997), 125–189.

40. Functional integration on the space of connections, with Stephen Sawin, *Jour. Funct. Analysis* **50** (1997), 1–27.

41. 2-Tangles, with Laurel Langford, *Lett. Math. Phys.* **43** (1998), 187–197.

42. Quantum geometry and black hole entropy, with Abhay Ashtekar, Alejandro Corichi and Kirill Krasnov, *Phys. Rev. Lett.* **80** (1998), 904–907.

43. Higher-dimensional algebra III: n-categories and the algebra of opetopes, with James Dolan, *Adv. Math.* **135** (1998), 145–206.

44. Spin foam models, *Class. Quantum Grav.* **15** (1998), 1827–1858.

45. Degenerate solutions of general relativity from topological field theory, *Commun. Math. Phys.* **193** (1998), 219–231.

46. Diffeomorphism-invariant spin network states, with Stephen Sawin, *Jour. Funct. Analysis* **158** (1998), 253–266.

47. Quantization of diffeomorphism-invariant theories with fermions, with Kirill Krasnov, *Jour. Math. Phys.* **39** (1998), 1251–1271.

48. Categorification, with James Dolan, in *Higher Category Theory,* eds. Ezra Getzler and Mikhail Kapranov, Contemp. Math. 230, American Mathematical Society, Providence, Rhode Island, 1998, pp. 1–36.

49. The quantum tetrahedron in 3 and 4 dimensions, with John Barrett, *Adv. Theor. Math. Phys.* **3** (1999), 815–850.

50. An introduction to spin foam models of BF theory and quantum gravity, in *Geometry and Quantum Physics*, eds. Helmut Gausterer and Harald Grosse, Lecture Notes in Physics, Springer, Berlin, 2000, pp. 25–93.

51. From finite sets to Feynman diagrams, with James Dolan, in *Mathematics Unlimited - 2001 and Beyond*, vol. 1, eds. Björn Engquist and Wilfried Schmid, Springer, Berlin, 2001, pp. 29–50.

52. Higher-dimensional algebra and Planck-scale physics, in *Physics Meets Philosophy at the Planck Length*, eds. Craig Callender and Nick Huggett, Cambridge U. Press, Cambridge, 2001, pp. 177–195.

53. Quantum geometry of isolated horizons and black hole entropy, with Abhay Ashtekar and Kirill Krasnov, *Adv. Th. Math. Phys.* **4** (2001), 1–94.

54. Integrability for relativistic spin networks, with John Barrett, *Class. Quantum Grav.* **18** (2001), 4683–4700.

55. The octonions, *Bull. Amer. Math. Soc.* **39** (2002), 145–205.

56. Positivity of spin foam amplitudes, with J. Daniel Christensen, *Class. Quantum Grav.* **19** (2002), 2291–2306.

57. Spin foam models of Riemannian quantum gravity, with J. Daniel Christensen, Thomas R. Halford and David C. Tsang, *Class. Quantum Grav.* **19** (2002), 4627–4648.

58. Uncertainty in measurements of distance, with S. Jay Olson, *Class. Quantum Grav.* **19** (2002), L121–L125.

59. Asymptotics of $10j$ symbols, with J. Daniel Christensen and Greg Egan, *Class. Quantum Grav.* **19** (2002), 6489–6513.

60. Spin foam perturbation theory, in *Diagrammatic Morphisms and Applications*, eds. David Radford, Fernando Souza, and David Yetter, Contemp. Math. **318**, American Mathematical Society, Providence, Rhode Island, 2003, pp. 9–21.

61. Higher-dimensional algebra IV: 2-tangles, with Laurel Langford, *Adv. Math.* **180** (2003), 705–764.

62. Higher-dimensional algebra V: 2-groups, with Aaron D. Lauda, *Theor. Appl. Categ.* **12** (2004), 423–491.

63. Higher-dimensional algebra VI: Lie 2-algebras, with Alissa S. Crans, *Theor. Appl. Categ.* **12** (2004), 492–528.

64. The meaning of Einstein's equation, with Emory F. Bunn, *Amer. Jour. Phys.* **73** (2005), 644–652.

65. Quantum quandaries: a category-theoretic perspective, in *Structural Foundations of Quantum Gravity*, eds. Steven French, Dean Rickles and Juha Saatsi, Oxford U. Press, Oxford, 2006, pp. 240–265.

66. Higher gauge theory, with Urs Schreiber, in *Categories in Algebra, Geometry and Mathematical Physics*, eds. Alexei Davydov, Michael Batanin, Michael Johnson, Stephen Lack and Amnon Neeman, Contemp. Math. **431**, American Mathematical Society, Providence, Rhode Island, 2007, pp. 7–30.

67. Quantization of strings and branes coupled to BF theory, with Alejandro Perez, *Adv. Theor. Math. Phys.* **11** (2007), 1–19.

68. From loop groups to 2-groups, with Alissa S. Crans, Danny Stevenson and Urs Schreiber, *Homotopy, Homology, and Appl.* **9** (2007), 101–135.

69. Exotic statistics for strings in 4d BF theory, with Alissa S. Crans and Derek Wise, *Adv. Theor. Math. Phys.* **11** (2007), 707–749.

70. Lectures on n-categories and cohomology, with Michael Shulman, in *Towards Higher Categories*, eds. John Baez and Peter May, Springer, Berlin, 2009.

71. The classifying space of a topological 2-group, with Danny Stevenson, in *Algebraic Topology: the Abel Symposium 2007*, eds. Nils Baas, Eric Friedlander, Bjørn Jahren and Paul Arne Østvær, Springer, Berlin, 2009.

72. Categorified symplectic geometry and the classical string, with Alexander E. Hoffnung and Christopher L. Rogers, in *Comm. Math. Phys.* **293** (2010), 701–715.

73. Categorified symplectic geometry and the string Lie 2-algebra, with Christopher L. Rogers, in *Homotopy, Homology and Applications* **12** (2010), 221–236.

74. The algebra of grand unified theories, with John Huerta, *Bull. Amer. Math. Soc.* **47** (2010), 483–552.

75. Divsion algebras and supersymmetry I, with John Huerta, in *Superstrings, Geometry, Topology, and C^*-algebras*, eds. Robert Doran, Greg Friedman, and Jonathan Rosenberg, *Proc. Symp. Pure Math.* **81**, AMS, Providence, Rhode Island, 2010, pp. 65–80.

76. Physics, topology, logic and computation: a Rosetta Stone, with Mike Stay, in *New Structures for Physics*, ed. Bob Coecke, Lecture Notes in Physics vol. 813, Springer, Berlin, 2011, pp. 95–174.

77. Higher-dimensional algebra VII: groupoidification, with Alexander E. Hoffnung and Christopher D. Walker, *Theor. Appl. Categ.* **24** (2010), 489–553.

78. A prehistory of n-categorical physics, with Aaron D. Lauda, in *Deep Beauty: Mathematical Innovation and the Search for an Underlying Intelligibility of the Quantum World*, ed. Hans Halvorson, Cambridge U. Press, Cambridge, pp. 13-128.

79. Convenient categories of smooth spaces, with Alexander E. Hoffnung, *Trans. Amer. Math. Soc.* **363** (2011), 5789–5825.

80. An invitation to higher gauge theory, with John Huerta, *General Relativity and Gravitation* **43** (2011), 2335–2392

81. A characterization of entropy in terms of information loss, with Tobias Fritz and Tom Leinster, *Entropy* **13** (2011), 1945–1957.

82. Division algebras and supersymmetry II, with John Huerta, *Adv. Math. Theor. Phys.* **15** (2011), 1373–1410.

83. Division algebras and quantum theory, *Found. Phys.* **42** (2012), 819–855.

84. Algorithmic thermodynamics, with Mike Stay, *Math. Struct. Comp. Sci.* **22** (2012), 771–787.

85. A Noether theorem for Markov processes, with Brendan Fong, *Jour. Math. Phys.*, **54** (2013), 013301.

86. Quantum techniques for studying equilibrium in chemical reaction networks, with Brendan Fong, *Jour. Complex Networks* **3** (2014), 22–34.

87. A Bayesian characterization of relative entropy, with Tobias Fritz, *Theor. Appl. Categ.* **29** (2014), 421–456.

88. G_2 and the rolling ball, with John Huerta, *Trans. Amer. Math. Soc.* **366** (2014), 52570–5293.

89. Wormholes and entanglement, with Jamie Vicary, *Class. Quant. Grav.* **31** (2014), 214007.

90. Quantropy, with Blake Pollard, *Entropy* **17** (2015), 772–789.

91. Teleparallel gravity as a higher gauge theory, with Derek Wise, *Comm. Math. Phys.* **333** (2015), 153–186.

92. Categories in control, with Jason Erbele, *Theor. Appl. Categ.* **30** (2015), 836–881.

93. The Lebesgue universal covering problem, with Karine Bagdasaryan and Philip Gibbs, *Jour. Comp. Geom.* **6** (2015), 288–299.

94. Relative entropy in biological systems, with Blake S. Pollard, *Entropy* **18** (2016), 46.

95. A compositional framework for Markov processes, with Brendan Fong and Blake S. Pollard, *Jour. Math. Phys.* **57** (2016), 033301.

96. A compositional framework for reaction networks, with Blake S. Pollard, *Rev. Math. Phys.* **29** (2017), 1750028.

97. Operads and phylogenetic trees, with Nina Otter, *Theor. Appl. Categ.* **32** (2017), 1397–1453.

POPULARIZATIONS

1. The quantum of area?, *Nature* **421** (2003), 702–703.

2. Social structures that enable inventions, in *The Greatest Inventions of the Past 2000 Years*, ed. John Brockman, Simon and Schuster, 2000, pp. 68–69.

3. The string-loop war, in *What Have You Changed Your Mind About?*, ed. John Brockman, Harper, 2009, pp. 156–158.

4. The Earth—for physicists, *PhysicsWorld*, July 2009.

5. The strangest numbers in string theory, with John Huerta, *Scientific American*, May 2011, pp. 60-65. Reprinted in *The Best Writing on Mathematics 2012*, ed. Mircea Pitici, Princeton U. Press, Princeton, New Jersey, 2013.

6. From the icosahedron to E_8, *London Math. Soc. Newsletter* **476** (2018), 18–23.

BOOK REVIEWS

1. *The Physical Basis of the Direction of Time*, by H. D. Zeh, review in *Math. Intelligencer* **16** (1994), 72–75.

2. *On Quaternions and Octonions: Their Geometry, Arithmetic, and Symmetry*, by John H. Conway and Derek A. Smith, review in *Bull. Amer. Math. Soc.* **42** (2005), 229–243.

3. *Cakes, Custard and Category Theory: Easy Recipes for Understanding Complex Maths*, by Eugenia Cheng, review in *London Math. Soc. Newsletter***451** (2015), 34.

RECENT TALKS

1. "Quantum Gravity", Southern California Reading Group in the Philosophy of Physics, January 2010.

2. "8", Mathematics Department, Fullerton College, California, March 2010.

3. "5" and "Physics, Topology, Logic and Computation: a Rosetta Stone", Mathematics and Physics Departments, California State University, Fresno, April 2010.

4. "Electrical Circuits", Einstein Chair Mathematics Seminar, City University of New York, May 2010.

5. "Duality in Logic and Physics", Quantum Physics and Logic 10, Oxford University, May 2010.

6. "Energy, the Environment, and What Mathematicians Can Do", Department of Mathematics, Hong Kong University, March 2011.

7. "8", Institute of Mathematical Sciences, Chinese University of Hong Kong, March 2011.

8. "Higher Gauge Theory, Division Algebras and Superstrings," Workshop on Geometry and Lie Groups, Department of Mathematics, Hong Kong University, March 2011.

9. "Higher Gauge Theory, Division Algebras and Superstrings," Quantum Theory and Gravitation, ETH Zurich, June 2011.

10. "Operads and the Tree of Life", Combinatorics Seminar, Department of Mathematics, Université du Québec é Montréal, July 2011.

11. "Probabilities versus Amplitudes", invited talk, CQT Annual Symposium, Centre for Quantum Technologies, Singapore, December 2011.

12. "Network Theory", four lectures at Expository Quantum Lecture Series 5 at the Institute for Mathematical Research, Universiti Putra Malaysia, January 2012.

13. "Energy, the Environment and What We Can Do", public lecture at the Universiti Putra Malaysia, January 2012.

14. "Probabilities versus Amplitudes", invited talk, Coogee '12 Sydney Quantum Information Theory Workshop, Sydney, Australia, February 2012.

15. "Probabilities versus Amplitudes", Mathematics Department, Macquarie University, Australia, February 2012.

16. "Energy, the Environment and What We Can Do", Macquarie University, Australia, February 2012.

17. "Symmetric Monoidal Categories in Chemistry and Biology", Australian Category Seminar, Mathematics Department, Macquarie University, Australia, February 2012.

18. "Energy, the Environment and What We Can Do", Google, Mountain View, California, February 2012.

19. "The Beauty of Roots", Topology Seminar, Mathematics Department, National University of Singapore, February 2012.

20. "G_2 and the Rolling Ball" and "Teleparallel Gravity and Higher Gauge Theory", Mathematics Department, University of Hong Kong, May 2012.

21. "Stochastic Petri Nets and Chemical Reactions", Preuves, Programmes et Systèmes group at Université Paris 7, June 2012.

22. "Diversity, Entropy and Thermodynamics", invited talk at Mathematics of Biodiversity, Centre de Recerca Matemàtica, Barcelona, July 2012.

23. "The Mathematics of Planet Earth", Mathematics Department, University of Southern California, October 2012.

24. "The Mathematics of Planet Earth", plenary talk at the 55th Annual Congress of the South African Mathematical Society, Stellenbosch University, South Africa, October 2012.

25. "The Mathematics of Planet Earth", Serge Lang Lecture, Mathematics Department, University of California at Berkeley, November 2012.

26. "The Azimuth Project: an Open-Access Educational Resource", American Geophysical Union Fall Meeting, December 2012.

27. "Network Theory", Econometrics Colloquium, Economics Department, University of California, Riverside, January 2013.

28. "The Mathematics of Planet Earth", Mathematics Institute, Warwick University, United Kingdom, January 2013.

29. "Bicategories and Tricategories of Spans", 94th Peripatetic Seminar on Sheaves and Logic, University of Sheffield, March 2013.

30. "The Mathematics of Planet Earth", public lecture, British Mathematical Colloquium, University of Sheffield, United Kingdom, March 2013.

31. "Spans and the Categorified Heisenberg Algebra", University of Nottingham, United Kingdom, March 2013.

32. "Energy and the Environment - What Physicists Can Do", colloquium, Perimeter Institute, April 2013.

33. "Energy and the Environment - What Physicists Can Do", Moreno Valley College, California, April 2013.

34. "Key Developments in Category Theory", Department of Logic and Philosophy of Science, University of California, Irvine, May 2013.

35. "The Foundations of Applied Mathematics", Category-Theoretic Foundations of Mathematics Workshop, University of California, Irvine, May 2013.

36. "Spans and the Categorified Heisenberg Algebra", 3-hour course, Higher Structures in China IV, Lanzhou University, China, June 2013.

37. "Spans and the Categorified Heisenberg Algebra", Quantum Mathematics and Computation Symposium, Mathematical Institute, University of Oxford, October 2013.

38. "Learning to Live on a Finite Planet" TEDxCrocetta, Turin, Italy, October 2013.

39. "What is Climate Change?" and "What To Do About It?", invited lectures at What is Climate Change and What To Do About It?, Balsillie School of International Affairs, University of Waterloo, Canada, October 2013.

40. "Petri Nets, Chemistry, and Quantum Theory", Department of Computer Science, California Institute of Technology, October 2013.

41. "The Mathematics of Planet Earth", Open University, United Kingdom, November 2013.

42. "Life's Struggle to Survive", SETI Institute, Mountain View, California, December 2013.

43. "Categories in Control", Mathematical Physics Seminar, Friedrich-Alexander-Universität Erlangen-Nrnberg, February 2014.

44. "Network Theory", four lectures at the Department of Computer Science, University of Oxford, February-March 2014.

45. "Operads and the Tree of Life", Topology Seminar, Mathematical Institute, University of Oxford, February 2014.

46. "The Mathematics of Planet Earth", Department of Computer Science, University of Birmingham, February 2014.

47. "Fock Space Techniques for Stochastic Physics", Quantum Field Theory Seminar, Institute of Mathematics, University of Oxford, March 2014.

48. "The Mathematics of Planet Earth", Department of Pure Mathematics and Mathematical Statistics, University of Cambridge, March 2014.

49. "Network Theory", lecture as part of Category Theory at the Crossroads, Schloss Dagstuhl, Germany, May 2014.

50. "Operads and the Tree of Life", Topology Seminar, Université de Lille, Lille, France, May 2014.

51. "Operads and the Tree of Life", invited lecture, Institut Henri Poincaré, Paris, May 2014.

52. "Spans and the Categorified Heisenberg Algebra", Catégories, Logiques, Etc., Université Paris Diderot, Paris, May 2014.

53. "Network Theory", Computer Science Seminar, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany, May 2014.

54. "Biodiversity, Entropy and Thermodynamics", invited lecture at Biological and Bio-Inspired Information Theory, Banff International Resarch Station, October 2014.

55. "Networks in Climate Science", plenary talk at Neural Information Processing Systems 2014, Montréal, Canada, December 2014.

56. "Information and Entropy in Biological Systems", introductory talk at the Investigative Workshop on Information and Entropy in Biological Systems at the National Institute for Mathematical and Biological Synthesis, Knoxville, Tennessee, April 2015.

57. "Split octonions and the rolling ball", Geometry-Analysis-Physics Seminar, Mathematics Department, Pennsylvania State University, April 2015.

58. "The exceptional Jordan algebra and the Leech lattice", Geometry Luncheon Seminar, Mathematics Department, Pennsylvania State University, April 2015.

59. "8", University of York Mathematics Society, April 2015.

60. "Categories in Control" and "Circuits, Categories and Rewrite Rules", invited lectures at Higher-Dimensional Rewriting and Applications, Warsaw, June 2015.

61. "Probabilities versus Amplitudes", invited lecture at Workshop on Mathematical Trends in Reaction Network Theory, University of Copenhagen, June 2015.

62. "Categories in Control", invited lecture at Broadcom, Irvine, California, November 2015.

63. "Categories in Control", session on Logic, Category Theory and Computation at the winter meeting of the Canadian Mathematical Society, Montreal, December 2015.

64. "The Answer to the Ultimate Question of Life, the Universe, and Everything", invited public lecture at the winter meeting of the Canadian Mathematical Society, Montreal, December 2015.

65. "The Octonions", $4\frac{1}{2}$-hour minicourse at the 8th Minimeeting on Differential Geometry, Centro de Investigacon en Matemáticas, Guanajuato, Mexico, December 2015.

66. "My Favorite Number", Pure Mathematics and Combinatorics and Optimization joint colloquium, University of Waterloo, Waterloo, Canada, February 2016.

67. "Harmonic Vibrations", Bridges Lecture, St. Jerome University, Waterloo, Canada, February 2016.

68. "My Favorite Number: 24", Physics/Astronomy Colloquium, California State University Los Angeles, May 2016.

69. "The Answer to the Ultimate Question of Life, the Universe, and Everything", Fall Mathematics Association of American Southern California-Nevada Section meeting, California State Los Angeles, October 2016.

70. "The Mathematics of Networks", Colloquium, Santa Fe Institute, November 2016.

71. "Computation and Thermodynamics", Santa Fe Workshop on Statistical Physics, Information Processing and Biology, Santa Fe Institute, November 2016.

72. "The Mathematics of Networks", workshop on Compositionality, Simons Institute for the Theory of Computing, Berkeley, December 2016.

73. "Biology as Information Dynamics", invited lecture at Biological Complexity: Can it be Quantified?, Beyond Center, Arizona State University, February 2017.

74. "Biology as Information Dynamics", invited talk at the Stanford Complexity Group, April 2017.

75. "The Dodecahedron, the Icosahedron and E_8", plenary talk at the Annual General Meeting of the Hong Kong Mathematical Society, May 2017.

76. "The Mathematics of Open Reaction Networks" invited talk at Dynamics, Thermodynamics and Information Processing in Chemical Networks, University of Luxembourg, June 2017.

77. "Tales of the Dodecahedron: from Pythagoras through Plato to Poincaré", Department of Mathematics, University of Genoa, June 2017.

78. "Applied Category Theory", Department of Mathematics, University of Genoa, June 2017.

79. "The Rise and Spread of Algebraic Topology", plenary talk at Applied Algebraic Topology 2017, Hokkaido University, Sapporo, Japan, August 2017.

80. "Biology as Information Dynamics", General Biology Seminar, Caltech, November 2017.

81. "Compositional Deisgn and Tasking of Networks", Applied Category Theory: Bridging Theory & Practice, NIST, Gaithersburg Maryland, March 2018.

82. "The Mathematics of Networks", Collloquium, University of Wisconsin Madison, April 2018.

83. "Props in Network Theory", Applied Category Theory 2018, Lorentz Center, Leiden, Netherlands, April 2018.