Curriculum Vitae
List of Publications

Matilde Marcolli

2023

Citizenship: USA and Italy

Work Addresses:

- Department of Mathematics
  California Institute of Technology (Caltech)
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  Pasadena, CA 91125, USA
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Education

- June, 1997: Ph.D. Mathematics, The University of Chicago. Dissertation: *Three-dimensional aspects of Seiberg-Witten gauge theory*; Thesis advisor: Prof. Mel Rothenberg.
- December, 1994: Master Sc., Mathematics, The University of Chicago.
- June, 1993: *Laurea* in Physics, 110/110 summa cum laude, Università degli Studi, Milano Italy. Dissertation: *Classes of self equivalences of fibre bundles*; Thesis advisor: Professor R. A. Piccinini (Department of Mathematics).
- June 1988: *Maturità classica* 60/60, Liceo Classico A. Volta, Como Italy.

Employment History

Current and past academic positions

- **2019-present** named chair "Robert F. Christy Professor of Mathematics and Computing and Mathematical Sciences", California Institute of Technology.
- **2008-present** Professor, Department of Mathematics, California Institute of Technology. **(on leave from January 2018 through July 2020)**
- **2018-2020** Professor, Department of Mathematics, University of Toronto and Perimeter Institute for Theoretical Physics.

- **2013-2017** Distinguished Visiting Research Chair, Perimeter Institute for Theoretical Physics.
- **2003-2008** Associate Professor (with tenure), Max Planck Institute for Mathematics.
- **2000-2003**: Associate Professor, Max Planck Institut for Mathematics, Bonn, Germany.
- **1997-2000**: C.L.E. Moore Instructor, Department of Mathematics, Massachusetts Institute of Technology, USA.

Courtesy appointments

- **2020-present** Computing and Mathematical Sciences, Division of Engineering and Applied Sciences, California Institute of Technology.
- **2006-2010** Honorary Professor, Bonn University, Germany.
- **2001-present**: Courtesy appointment (Associate Professor – Professor), Mathematics Department, Florida State University, USA

Honors, Grants and Awards

Recent Distinguished Conference Invitations

- June 2020(2021): Plenary Lecture at the Canadian Mathematical Society 75th Anniversary Summer Meeting: Entropy, holography, and p-adic geometry
- Plenary speaker at "MOL 2019 – The 16th Meeting on the Mathematics of Language", University of Toronto, Canada, July 2019.
- Opening plenary lecture at "Geometric Science of Information", École Polytechnique, Paris, France, October 2015.
- Plenary speaker at the Pacific Rim Mathematical Association Congress, Shanghai, June 2014.
- Invited Speaker (Mathematical Physics) International Congress of Mathematicians, Hyderabad, August 2010.

- Plenary Speaker for the 5th European Congress of Mathematics, Amsterdam, July 2008.

Awards

- **2021** Geometric Science of Information Achievement Award
- **2021** PROSE Award, Mathematics Category, for the book "Lumen Naturae", MIT Press
- **2002** Sofja Kovalevskaya Award of the Alexander von Humboldt Foundation and the ZIP Program of the German Government.
- **2001**: Heinz Maier Leibnitz Prize awarded by the Deutsche Forschungsgemeinschaft

Support from the National Science Foundation (USA) and Natural Sciences and Engineering Research Council (Canada)

- **2021** National Science Foundation (NSF) grant DMS-2104330 "Arithmetic and Topological Structures in Physics"
- **2020** FQXi Foundation FQXI-RFP-CPW-2014 (SVCF 2020-224047) "Towards a Topological Model of Consciousness"
- **2018** Natural Sciences and Engineering Research Council NSERC-RGPIN-2018-04937 "New Geometric Models for Theoretical Physics and for Computational Linguistics"
- **2018** Natural Sciences and Engineering Research Council NSERC-RGPAS-2018-522593 Discovery Accelerator Supplement "New Geometric Models for Theoretical Physics and for Computational Linguistics"
- **2017** National Science Foundation (NSF) grant DMS-1707882 "Geometry and Arithmetic in Theoretical Physics"
- **2012** National Science Foundation (NSF) grant PHY-1205440 "Noncommutative Geometry Models for Physics"
- **2012** National Science Foundation (NSF) grant DMS-1201512 "Motivic Structures in Physics"

- **2010** National Science Foundation (NSF) grant DMS-1007207 "Arithmetic Noncommutative Geometry".
- **2009** National Science Foundation (NSF) grant DMS-0901221 "Feynman motives".
- **2007**: National Science Foundation (NSF) grant DMS-0651925 (part of NSF Focused Research Group "Noncommutative Geometry and Number Theory", with Alain Connes, Caterina Consani, Henri Moscovici)
- **1998**: National Science Foundation (NSF) grant DMS-9802480 "Seiberg–Witten Floer Theory"

Other Grants

- **2021** Caltech Center for Evolutionary Science award, "New Geometric Models for the Study of Language Evolution"
- **2018** FQXi Foundation FFF Grant number: FQXi-RFP-1804, SVCF grant number 2018-190467 "Homotopy Theory models in Neuroscience"
- **2010** Australian Research Council, Grant DP1092682 (with Alan Carey and Bai-Ling Wang) "Invariants of singular spaces from noncommutative geometry"
- **2007** Australian Research Council, Grant DP0769986 "Geometric problems from quantum theory" (with Alan Carey and Michael Murray)
- **2004**: Australian Research Council, Grant DP0449470 "Geometric methods in quantum theory" (with Alan Carey and Michael Murray)
- **1995**: *Borsa di Studio e Ricerca*, Research Grant awarded by the National Council of Research (CNR) of Italy.

Short Term Visiting Positions

- **April 2018**: Visiting Professor University of Utrecht, joint invitation of the Mathematics Department, the Utrecht Institute of Linguistics OTS, and the Centre for Complex Systems Studies

- **January-May 2013**: Research Professor, Mathematical Sciences Research Institute, Berkeley
- **January-April 2009**: Research Professor, Mathematical Sciences Research Institute, Berkeley
- **July 2009**: Max Planck Institute for Mathematics.
- **April 2007**: Visitor at the Mittag Leffler Institute, Stockholm, Sweden.
- **Fall 2006**: Newton Institute Cambridge, UK.
- **Nov 2005**: Visitor at the Kavli Institute of Theoretical Physics Santa Barbara, USA.
- **May 2005**: Visitor (Kempf Lectures), Johns Hopkins university, USA.
- **April-May 2005**: Visiting scholar, Vanderbilt University, USA
- **May-June 1999**: Visiting position at the Max Planck Institut für Mathematik, Bonn, Germany.
- **January 1999**: Visiting position at the Tata Institute of Fundamental Research, Mumbai, India.
- **June-August 1998**: Visiting position at the Max Planck Institut für Mathematik, Bonn, Germany.
- **July 1996**: Guest of the program "Research in Pairs" (for collaborative research with M. Spreafico) at the Mathematisches Forschungsinstitut Oberwolfach, Germany.

Journal Editor

- Letters in Mathematical Physics
- Journal of Mathematical Physics
- Journal of Geometry and Physics
- Springer Briefs in Mathematical Physics

- Mathematics in Computer Science
- Journal of Fractal Geometry
- Journal of Noncommutative Geometry
- p-adic Numbers, Ultrametric Analysis and Applications
- Bulletin of the Italian Mathematical Union
- Analysis, Geometry, and Number Theory
- Advances in Mathematical Physics (2008-2014)

List of Refereed Publications

Books authored

1. *Lumen Naturae: Visions of the Abstract in Art and Mathematics*, MIT Press, 2020.
   (Subject Category Winner, Association of American Publishers (AAP) Professional and Scholarly Excellence (PROSE) Awards 2021)

2. *Noncommutative Cosmology*, World Scientific, 2018.

3. *Feynman Motives*, World Scientific, 2010.

4. *Noncommutative Geometry, Quantum Fields and Motives*, (with Alain Connes) Colloquium Publications, Vol.55, American Mathematical Society, 2008.

5. *Arithmetic noncommutative geometry*, University Lectures Series, Vol.36, American Mathematical Society, 2005.

6. *Seiberg–Witten gauge theory*, Texts and Readings in Mathematics, Vol.17, Hindustan Book Agency, New Delhi, 1999, viii+228 pp.

Articles published in refereed journals

7. *Moufang Patterns and Geometry of Information* (with N.C.Combe and Yu.I.Manin) Pure and Applied Mathematics Quarterly, Vol. 19 (2023) 149–189.

8. *Gabor frames from contact geometry in models of the primary visual cortex* (with Vasiliki Liontou) Mathematical Neuroscience and Applications, June 6, 2023, Volume 3, Article mna.9766 [28 pages]

9. *Modular Nori Motives* (with Noemie C. Combe and Yuri I.Manin) to appear in p-Adic Numbers, Ultrametric Analysis and Applications

10. *Holographic tensor networks from hyperbolic buildings*, (with Elliott Gesteau and Sarthak Parikh) Journal of High Energy Physics (2022), no. 10, Paper No. 169, 28 pp.

11. *Fractality in Cosmic Topology Models with Spectral Action Gravity* (with Pedro Guicardi) Class. Quantum Grav. 39 (2022) 165007 (55pp)

12. *Topological Analysis of Syntactic Structures* (with Alexander Port and Taelin Karidi) Mathematics in Computer Science, Vol. 16 (2022), no. 1, Paper No. 2, 68 pp.

13. *Geometry of Information: Classical and Quantum aspects* (with N.C.Combe and Yu.I.Manin) Theoretical Computer Science, Vol.908 (2022) 2–27.

14. *Functor of Points and Height Functions for Noncommutative Arakelov Geometry* (with Alicia Lima) Journal of Geometry and Physics, Vol.169 (2021), Paper No. 104337, 28 pp.

15. *Motives of melonic graphs* (with Paolo Aluffi and Waleed Qaisar) arXiv:2007.08565 to appear in Annales de l'Institut Henri Poincaré D

16. *Heat Kernel analysis of Syntactic Structures* (with Andrew Ortegaray, Robert C. Berwick) Mathematics in Computer Science, Vol. 15 (2021), 643–660.

17. *Phylogenetics of Indo-European Language families via an Algebro-Geometric Analysis of their Syntactic Structures* (with Kevin Shu, Andrew Ortegaray, Robert C. Berwick) Mathematics in Computer Science, Vol. 15 (2021), 803–857.

18. *Gluing Noncommutative Twistor Spaces* (with Roger Penrose) The Quarterly Journal of Mathematics, 72 (2021), no. 1-2, 417–454.

19. *Anyon Networks from Geometric Models of Matter* (with Michael Atiyah) The Quarterly Journal of Mathematics, 72 (2021), no. 1-2, 717–733

20. *Nonarchimedean Holographic Entropy from Networks of Perfect Tensors* (with Matthew Heydeman, Sarthak Parikh, Ingmar Saberi) Advances in Theoretical and Mathematical Physics, Vol. 25 (2021) N.3, 591-721.

21. *Quantum Statistical Mechanics of the Absolute Galois Group* (with Yuri Manin) SIGMA 16 (2020), 038, 52 pages.

22. *Bell polynomials and Brownian bridge in Spectral Gravity models on multifractal Robertson-Walker cosmologies* (with Farzad Fathizadeh, Yeorgia Kafkoulis), Ann. Henri Poincaré 21 (2020), no. 4, 1329–1382.

23. *Nori diagrams and persistent homology* (with Yuri Manin) Mathematics in Computer Science, 14 (2020) N.1, 77–102.

24. *Holographic Codes on Bruhat–Tits buildings and Drinfeld Symmetric Spaces*, Pure and Applied Mathematics Quarterly, Vol. 16 (2020), No. 1, 1–33.

25. *Adinkras, Dessins, Origami, and Supersymmetry Spectral Triples* (with Nick Zolman), p-Adic Numbers, Ultrametric Analysis and Applications, Vol.11 (2019), N.3, 223–247.

26. *Asymptotic bounds for spherical codes* (with Yuri Manin) Izvestiya Mat. 83 (2019) N.3, 117–141.

27. *Reconstructing global fields from dynamics in the abelianized Galois group* (with Gunther Cornelissen, Xin Li, Harry Smit) Selecta Mathematica (N.S.) 25 (2019), no. 2, 25: 24 [18 pages]

28. *Characterization of global fields by Dirichlet L-series* (with Gunther Cornelissen, Bart de Smit, Xin Li, Harry Smit) Res. Number Theory 5 (2019), no. 1, 5:7 [15 pages]

29. *Modular forms in the spectral action of Bianchi IX gravitational instantons*, (with Wentao Fan, Farzad Fathizadeh) Journal of High Energy Physics (2019) 234 [38 pages]

30. *Motivic Information*, Boll. Unione Mat. Ital., Vol.12 (2019) N.1-2, 19–41.

31. *Gamma Spaces and Information*, Journal of Geometry and Physics, 140 (2019) 26–55.

32. *Feynman quadrics-motive of the massive sunset graph* (with Goncalo Tabuada) J. Number Theory 195 (2019), 159–183

33. *Tensor networks, p-adic fields, and algebraic curves: arithmetic and the AdS_3/CFT_2 correspondence* (with Matthew Heydeman, Ingmar Saberi, Bogdan Stoica), Advances in Theoretical and Mathematical Physics, Vol. 22 (2018) N. 1, 93–176.

34. *Motives and periods in Bianchi IX gravity models* (with Wentao Fan, Farzad Fathizadeh) Lett. Math. Phys. 108 (2018), no. 12, 2729–2747.

35. *Some remarks concerning Voevodsky's nilpotence conjecture* (with Marcello Bernardara, Goncalo Tabuada) J. Reine Angew. Math. 738 (2018) 299–312

36. *Persistent Topology of Syntax* (with A. Port, I. Gheorghita, D. Guth, J.M. Clark, C. Liang, S. Dasu) Math. Comput. Sci. 12 (2018) no. 1, 33–50.

37. *Periods and motives in the spectral action of Robertson-Walker spacetimes* (with F. Fathizadeh) Comm. Math. Phys. 356 (2017), no. 2, 641–671.

38. *Anyons in Geometric Models of Matter* (with Michael Atiyah) J. High Energy Phys. 2017, no. 7, 076, front matter+23 pp.

39. *Edge length dynamics on graphs with applications to p-adic AdS/CFT*, (with Steven S. Gubser, Matthew Heydeman, Christian Jepsen, Sarthak Parikh, Ingmar Saberi, Bogdan Stoica, Brian Trundy) J. High Energy Phys. 2017, no. 6, 157, front matter+34 pp.

40. *Twisted index theory on orbifold symmetric products and the fractional quantum Hall effect* (with Kyle Seipp) Adv. Theor. Math. Phys. 21 (2017), no. 2, 451–501

41. *Spin Glass Models of Syntax and Language Evolution* (with Karthik Siva, Jim Tao) Linguistic Analysis, Vol.41 (2017) N.3-4, 559–608.

42. *Periods and motives in the spectral action of Robertson-Walker spacetimes* (with Farzad Fathizadeh) Communications in Mathematical Physics, Vol.356 (2017) N.2, 641–671

43. *Bost-Connes systems, Categorification, Quantum Statistical Mechanics, and Weil Numbers* (with Goncalo Tabuada) Journal of Noncommutative Geometry, 11 (2017), no. 1, 1–49.

44. *q-deformations of statistical mechanical systems and motives over finite fields* (with Zhi Ren), p-Adic Numbers Ultrametric Anal. Appl. 9 (2017), no. 3, 204–227.

45. *Quantum statistical mechanics in arithmetic topology* (with Yujie Xu) Journal of Geometry and Physics, Vol. 114 (2017) 153–183.

46. *Syntactic Structures and Code Parameters* (with Kevin Shu) Mathematics in Computer Science, 11 (2017), no. 1, 79–90

47. *Spectral action gravity and cosmological models*, Comptes Rendus Physique, Vol. 18 (2017) N. 3–4, 226–234.

48. *Syntactic Parameters and a Coding Theory Perspective on Entropy and Complexity of Language Families*, Entropy, Vol.18 (2016) N.4, 17 pages

49. *Semantic Spaces* (with Yuri Manin) Mathematics in Computer Science, Vol.10 (2016) N.4, 459–477

50. *Noncommutative numerical motives, Tannakian categories, and motivic Galois groups* (with Goncalo Tabuada), Journal of the European Mathematical Society (JEMS) 18 (2016), no. 3, 623–655.

51. *Spectral Action Models of Gravity on Packed Swiss Cheese Cosmology* (with Adam Ball) Classical Quantum Gravity 33 (2016), no. 11, 115018, 39 pages

52. *Symbolic dynamics, modular curves, and Bianchi IX cosmologies* (with Yuri Manin) Annales de la Faculté des Sciences de Toulouse, Vol. XXV (2016) N. 2–3, 313–338.

53. *KMS weights on higher rank buildings* (with Jake Marcinek) p-Adic Numbers Ultrametric Anal. Appl. 8 (2016), no. 1, 45–67.

54. *Rota-Baxter algebras, singular hypersurfaces, and renormalization in Kausz compactifications* (with Xiang Ni), Journal of Singularities, Vol.15 (2016) 80–117.

55. *Locality of gravitational systems from entanglement of conformal field theories* (with Jennifer Lin, Hirosi Ooguri, Bogdan Stoica) Physical Review Letters, 114 221601 (2015)
(archive version "Tomography from Entanglement", arXiv:1412.1879)

56. *From exceptional collections to motivic decompositions via noncommutative motives* (with Goncalo Tabuada) J. Reine Angew. Math. 701 (2015) 153–167.

57. *Spectral Action for Bianchi Type-IX Cosmological Models* (with Wentao Fan, Farzad Fathizadeh) J. High Energy Phys. 2015, no. 10, 085, front matter+28 pp.

58. *Graph Grammars, Insertion Lie Algebras, and Quantum Field Theory* (with Alex Port) Math. Comput. Sci. 9 (2015), no. 4, 391–408

59. *Potts models with magnetic field: arithmetic, geometry, and computation* (with Shival Dasu) J. Geom. Phys. 97 (2015), 14–24

60. *Entropy algebras and Birkhoff factorization* (with Nicolas Tedeschi) J. Geom. Phys. 97 (2015), 243–265

61. *Quantum computation and real multiplication* (with John Napp) Mathematics in Computer Science, 9 (2015), no. 1, 63–84.

62. *F-zeta geometry, Tate motives, and the Habiro ring* (with Catharine Wing Kwan Lo), International Journal of Number Theory, 11 (2015) N.2, 311–339.

63. *Algebraic renormalization and Feynman integrals in configuration spaces* (with Ozgur Ceyhan) Advances in Theoretical and Mathematical Physics, Vol.18 (2014) 469–511.

64. *Kolmogorov complexity and the asymptotic bound for error-correcting codes* (with Yuri Manin) Journal of Differential Geometry, Vol.97 (2014) 91–108.

65. *Big Bang, Blow up, and modular curves: algebraic geometry in cosmology* (with Yuri Manin) SIGMA 10 (2014), 073, 20 pages

66. *Noncommutative motives, numerical equivalence, and semi-simplicity* (with Goncalo Tabuada) American Journal of Mathematics, Vol.136 (2014) N.1, 59-75

67. *Noncommutative Artin motives* (with Goncalo Tabuada) Selecta Mathematica, Vol.20 (2014) N.1, 315-358.

68. *Jacobians of Noncommutative Motives* (with Goncalo Tabuada) Moscow Mathematical Journal, Vol.14 (2014) N.3, 577-594

69. *Coupling of gravity to matter, spectral action and cosmic topology* (with Branimir Cacic and Kevin Teh) Journal of Noncommutative Geometry, Vol.8 (2014) N.2, 473–504

70. *Thermodynamic Semirings* (with Ryan Thorngren) Journal of Noncommutative Geometry, Vol.8 (2014) N.2, 337–392

71. *Endomotives of Toric Varieties* (with Zhaorong Jin) Journal of Geometry and Physics, Vol. 77 (2014) 48-71

72. *Gauge Networks in Noncommutative Geometry* (with Walter van Suijlekom) Journal of Geometry and Physics, Vol.75 (2014) 71-91

73. *Multifractals, Mumford curves, and Eternal Inflation* (with Nicolas Tedeschi) p-Adic Numbers, Ultrametric Analysis and Applications, Vol.6 (2014) N.2, 135-154.

74. *Twisted spectral triples and quantum statistical mechanical systems* (with Mark Greenfield and Kevin Teh) p-adic Numbers, Ultrametric Analysis, and Applications, Vol.6 (2014) N.2, 81-104.

75. *A motivic approach to phase transitions in Potts models* (with Paolo Aluffi) Journal of Geometry and Physics, Vol.63 (2013) 6–31.

76. *Graph reconstruction and quantum statistical mechanics* (with Gunther Cornelissen) Journal of Geometry and Physics, Vol.72 (2013) 110–117.

77. *Quantum field theory over F_1* (with Dori Bejleri) Journal of Geometry and Physics, 69 (2013) 40–59.

78. *Asymptotic safety, hypergeometric functions and the Higgs mass in spectral action models* (with Christopher Estrada), International Journal of Geometric Methods in Modern Physics, Vol.10 (2013) N.7, 1350036 [30 pages]

79. *Arithmetic of Potts model hypersurfaces* (with Jessica Su) International Journal of Geometric Methods in Modern Physics Vol. 10, No. 4 (2013) 1350005 [22 pages]

80. *Noncommutative Mixmaster cosmologies* (with Christopher Estrada) International Journal of Geometric Methods in Modern Physics, Vol.10 (2013) N.1 [28 pages]

81. *Kontsevich's noncommutative numerical motives* (with Goncalo Tabuada) Compositio Mathematica, Vol.148 (2012) N.6, 1811–1820.

82. *Feynman integrals and motives of configuration spaces* (with Ozgur Ceyhan) Communications in Mathematical Physics: Vol.313, N.1 (2012), Page 35–70.

83. *The coupling of topology and inflation in noncommutative cosmology* (with Elena Pierpaoli and Kevin Teh) Communications in Mathematical Physics, Vol.309 (2012) N.2, 341–369.

84. *Codes as fractals and noncommutative spaces* (with Christopher Perez) Mathematics in Computer Science, Vol.6 (2012) N.3, 199–215.

85. *The Ricci flow on noncommutative two-tori* (with Tanvir Ahamed Bhuyain) Letters in Mathematical Physics, Vol.101 (2012) N.2, 173–194.

86. *The spectral action and cosmic topology* (with Elena Pierpaoli and Kevin Teh) Communications in Mathematical Physics, 304 (2011) 125–174.

87. *Graph hypersurfaces and a dichotomy in the Grothendieck ring* (with Paolo Aluffi) Letters in Mathematical Physics, (2011) Vol.95, 223–232.

88. *Error-correcting codes and phase transitions* (with Yuri Manin) Mathematics in Computer Science, Vol.5 (2011) 133-170.

89. *Cuntz-Krieger algebras and wavelets on fractals* (with Anna Maria Paolucci) Complex Analysis and Operator Theory, Vol.5 (2011) N.1, 41-81.

90. *Algebro-geometric Feynman rules* (with Paolo Aluffi), International Journal of Geometric Methods in Modern Physics, Vol.8 (2011) N.1, 203–237.

91. *Building cosmological models via noncommutative geometry*, International Journal of Geometric Methods in Modern Physics, Vol.8, N.5 (2011) 1131–1168.

92. *Early Universe models from Noncommutative Geometry* (with Elena Pierpaoli) Advances in Theoretical and Mathematical Physics, Vol.14 (2010) 1373–1432.

93. *Parametric Feynman integrals and determinant hypersurfaces* (with Paolo Aluffi) Advances in Theoretical and Mathematical Physics, Vol.14 (2010) 911-963.

94. *Spin foams and noncommutative geometry* (with Domenic Denicola and Ahmad Zainy al-Yasry) Class. Quantum Grav. 27 (2010) 205025 (53pp)

95. *Boundary conditions of the RGE flow in the noncommutative geometry approach to particle physics and cosmology* (with Daniel Kolodrubetz) Physics Letters B 693 (2010) 166–174.

96. *Open string theory and planar algebras* (with Ozgur Ceyhan) J. Phys. A: Math. Theor. 43 (2010) 385401 (12pp)

97. *Cyclotomy and endomotives*, p-Adic Numbers, Ultrametric Analysis and Applications, Vol.1 (2009) N.3, 217-263.

98. *Feynman motives of banana graphs* (with Paolo Aluffi) Communications in Number Theory and Physics, Vol.3 (2009) N.1, 1-57.

99. *Fun with F_1* (with Alain Connes and Caterina Consani), Journal of Number Theory, Vol.129 (2009), N.6, 1532-1561.

100. *Solvmanifolds and noncommutative tori with real multiplication.* Communications in Number Theory and Physics, Vol.2 (2008) No.2, 423–479.

101. *Supermanifolds from Feynman graphs*, (with Abhijnan Rej) Journal of Physics A, Vol.41 (2008) 315402 (21pp).

102. *Coverings, correspondences, and noncommutative geometry* (with Ahmed Zainy al-Yasry) Journal of Geometry and Physics, Vol.58 (2008) N.12, 1639-1661

103. *Zeta functions that hear the shape of a Riemann surface* (with Gunther Cornelissen) Journal of Geometry and Physics, Vol.58 (2008) N.5, 619-632.

104. *On the K-theory of graph C^* algebras* (with Gunther Cornelissen and Oliver Lorscheid) Acta Applicandae Mathematicae, Vol.102 (2008) N.1, 57–69.

105. *Noncommutative geometry and motives: the thermodynamics of endomotives*, (with Alain Connes and Caterina Consani), Advances in Mathematics, Vol.214 (2007) N.2, 761–831.

106. *Gravity and the Standard Model with neutrino mixing* (with Ali Chamseddine and Alain Connes), Advances in Theoretical and Mathematical Physics, 11 (2007) 991–1090.

107. *Quantum statistical mechanics over function fields* (with Caterina Consani) Journal of Number Theory, 123 (2007) 487–528.

108. *Quantum Fields and motives* (with Alain Connes), Journal of Geometry and Physics, Vol. 56 (2006) N.1, 55–85.

109. *Q-lattices: quantum statistical mechanics and Galois theory* (with Alain Connes), Journal of Geometry and Physics, Vol. 56 (2006) N.1, 2–23.

110. *KMS states and complex multiplication*, (with Alain Connes and Niranjan Ramachandran) Selecta Math. (N.S.) Vol.11 (2005) N.3-4, 325–347.

111. *Renormalization and motivic Galois theory* (with Alain Connes), International Math. Research Notices (2004) N.76, 4073–4092.

112. *Noncommutative geometry, dynamics, and ∞-adic Arakelov geometry*, (with Caterina Consani), Selecta Mathematica, Vol.10 (2004) N.2, 167–251.

113. *Spectral triples from Mumford curves*, (with Caterina Consani), International Math. Research Notices, 36 (2003) 1945–1972.

114. *Limiting Modular symbols and the Lyapunov spectrum*, Journal of Number Theory, Vol.98 N.2 (2003) 348-376.

115. *The geometric triangle for 3-dimensional Seiberg-Witten monopoles*, (with Alan Carey and Bai-Ling Wang), Communications in Contemporary Mathematics, Vol.5 N.2 (2003) 197–250.

116. *Triplets spectraux en geometrie d'Arakelov*, (with Caterina Consani), Comptes Rendus Acad. Sci. Paris, Ser. I 335 (2002) 779–784.

117. *Weak UCP and perturbed monopole equations*, (with Bernhelm Booss-Bavnbek and Bai-Ling Wang), International Journal of Mathematics, Vol. 13 N.9 (2002) 987–1008.

118. *Seiberg-Witten and Casson-Walker invariant for rational homology spheres*, (with Bai-Ling Wang) Geometriae Dedicata, Vol.91 (2002), 45–58.

119. *Continued fractions, modular symbols, and noncommutative geometry*, (with Yuri Manin) Selecta Mathematica, New Ser. Vol.8 N.3 (2002) 475–520. (This paper got a Featured Review on the Mathematical Reviews: MR1931172)

120. *Holography principle and arithmetic of algebraic curves*, (with Yuri Manin), Advances in Theoretical and Mathematical Physics, Vol.5, N.3 (2001) 617-650.

121. *Equivariant Seiberg–Witten Floer homology*, (with Bai-Ling Wang), Communications in Analysis and Geometry, Vol.9 N.3 (2001) 451–639. (This paper got a Featured Review on the Mathematical Reviews: MR1895135)

122. *Twisted index theory on good orbifolds II: Fractional quantum numbers*, (with Varghese Mathai), Communications in Mathematical Physics, Vol.217 (2001) N.1 55–87.

123. *Twisted index theory on good orbifolds I: Noncommutative Bloch theory*, (with Varghese Mathai), Communications in Contemporary Mathematics, Vol.1 (1999) N.4, 553–587.

124. *Gauge groups and characteristic classes*, (with Mauro Spreafico), Expositiones Mathematicae, Vol.15 (1997) N.3, 229–249.

125. *Seiberg–Witten Floer homology and Heegaard splittings*, International Journal of Mathematics, 7 (1996) N.5, 671–696.

126. *Some remarks on conjugacy classes of bundle gauge groups*, Cahiers Topologie Géom. Différentielle Catég. 37 (1996) N.1, 21–39.

127. *Lorentz bundles*, Rend. Inst. Mat. Univ. Trieste 25 (1993) N.1-2, 309–315.

Refereed Book Chapters/Volume Contributions

128. *Quantum Operads* (with N.C.Combe and Yu.I.Manin) to appear in "CN Yang at 100", Springer, 2022. [arXiv:2112.15237]

129. *Birational maps and Nori motives* (with Noémie C. Combe, Yuri I. Manin) [arXiv:2012.13814] to appear in "Essays in geometry dedicated to Norbert A'Campo" (A. Papadopoulos, ed.), European Mathematical Society, 2022

130. *Homotopy Spectra and Diophantine Equations* (with Yuri Manin) to appear in "The Literature and History of Mathematical Science", International Press, 2021. [arXiv:2101.00197]

131. *Bost-Connes systems and F1-structures in Grothendieck rings, spectra, and Nori motives* (with Joshua F. Lieber, Yuri I. Manin) in "Facets of Algebraic Geometry", Vol. II, pp. 147–227, London Math. Soc. Lecture Note Ser., 473, Cambridge Univ. Press, 2022.

132. *Topological Models of Neural Information Networks*, in "Geometric Science of Information. 5th International Conference, GSI 2021", Lecture Notes in Computer Science, Vol. 12829, pp. 623–633, Springer, 2021.

133. *Aspects of p-adic geometry related to entanglement entropy* in "Integrability, Quantization, and Geometry, II", pp. 353–382, Proceedings of Symposia in Pure Mathematics, Vol.103.2, American Mathematical Society, 2021

134. *Dessins for Modular Operad and Grothendieck-Teichmüller Group* (with Noemie C. Combe, Yuri I. Manin) arXiv:2006.13663 to appear in "Topology and Geometry A Collection of Essays Dedicated to Vladimir G. Turaev", (ed. A. Papadopoulos), European Mathematical Society, 2021

135. *Homotopy types and geometries below* $\mathrm{Spec}(Z)$ (with Yuri Manin) in "Dynamics: Topology and Numbers", pp. 27–56, Contemporary Mathematics, Vol. 744, American Mathematical Society, 2020.

136. *Feynman integrals and periods in configuration spaces* (with Ozgur Ceyhan), in "Amplitudes, Hodge Theory and Ramification: From Periods and Motives to Feynman Amplitudes", Clay Mathematics Proceedings Vol. 21, Clay Mathematical Institute and American Mathematical Society, 2020, pp. 35–102.

137. *Intersection theory, characteristic classes, and algebro-geometric Feynman rules* (with Paolo Aluffi) in "MathemAmplitudes 2019: Intersection Theory & Feynman Integrals", Proceedings of Science, PoS (MA2019) 012 [36 pages]

138. *Syntactic Phylogenetic Trees* (with Kevin Shu, Sharjeel Aziz, Vy-Luan Huynh, David Warrick) in "Foundations of Mathematics and Physics one Century after Hilbert" (Joseph Kouneiher, Ed.) Springer Verlag, 2018, pp. 417–441.

139. *Prevalence and recoverability of syntactic parameters in sparse distributed memories* (with Jeong Joon Park, Ronnel Boettcher, Andrew Zhao, Alex Mun, Kevin Yuh, Vibhor Kumar) in "Geometric Structures of Information 2017", Lecture Notes in Computer Science, Vol. 10589 (2017) 1–8.

140. *Moduli Operad over F_1* (with Yuri Manin) in "Absolute arithmetic and F1 geometry" (K.Thas, Ed.), pp. 331–364, European Mathematical Society, 2016.

141. *Information algebras and their applications*, in "Geometric science of information", pp. 271–276, Lecture Notes in Comput. Sci., 9389, Springer, Cham, 2015.

142. *Unconditional noncommutative motivic Galois groups* (with Goncalo Tabuada), in "Hodge Theory and Classical Algebraic Geometry" (Editors: Gary Kennedy, Mirel Caibăr, Ana-Maria Castravet and Emanuele Macrì) pp. 109–115, Contemp. Math., Vol.647, Amer. Math. Soc., 2015.

143. *Noncommutative motives and their applications* (with Goncalo Tabuada) in "Commutative Algebra and Noncommutative Algebraic Geometry, I", (Editors: David Eisenbud, Srikanth Iyengar, Anurag Singh, Toby Stafford, Michel Van den Bergh), pp. 191–214, MSRI Publications, Vol.67, Cambridge University Press, 2015.

144. *Dyson-Schwinger equations in the theory of computation* (with Colleen Delaney) in "Feynman amplitudes, periods and motives" (Editors: Luis Álvarez-Cónsul, José Ignacio Burgos Gil, Kurusch Ebrahimi-Fard), pp. 79–107, Contemp. Math., Vol.648, Amer. Math. Soc., 2015.

145. *Feynman motives and deletion-contraction relations* (with Paolo Aluffi) in "Topology of Algebraic Varieties and Singularities", Contemporary Mathematics, Vol.538 (2011) 21-64, American Mathematical Society.

146. *Modular index invariants of Mumford curves* (with Alan Carey and Adam Rennie) in "Noncommutative Geometry, Arithmetic, and Related Topics", Johns Hopkins University Press, 2011, pp.31-74.

147. *Motivic ideas in noncommutative geometry* (an appendix to Introduction to Motives, by R.Sujatha and J.Plazas) in "Noncommutative Geometry and Physics: Renormalisation, Motives, Index Theory", European Mathematical Society, 2011, pp.61–87.

148. *Motivic ideas in physics* (an appendix to "Motives: an introductory survey for physicists" by Abhijnan Rej) in "Combinatorics and Physics",

Contemporary Mathematics, Vol.539 (2011), pp.407–415, American Mathematical Society

149. *Noncommutative geometry and arithmetic* (ICM talk) Proceedings of the ICM-2010, Hyderabad, Vol.III, 2057-2077, World Scientific/Hindustan Book Agency, 2010.

150. *Feynman integrals and motives*, in "European Congress of Mathematics, Amsterdam 14-18 July 2008", pp.293–332, European Mathematical Society, 2010.

151. *Motivic renormalization and singularities*, in "Quanta of Maths", Clay Mathematics Institute, Vol.11 (2010) 409-458.

152. *The Weil proof and the geometry of the adele class space*, (with Alain Connes and Katia Consani) in "Algebra, Arithmetic, and Geometry: in honor of Yu.I.Manin" Progress in Mathematics, Vol.270, Part I, Birkhauser 2009, 339-406.

153. *Modular shadows and the Levy-Mellin infinity-adic transform* (with Yuri Manin) in "Modular forms on Schiermonnikoog" (Eds. B.Edixhoven, G. van der Geer, B.Moonen) Cambridge University Press, 2008, pp. 189-238.

154. *A walk in the noncommutative garden* (with Alain Connes) in "An invitation to Noncommutative Geometry", pp.1-128, World Scientific, 2008.

155. *Noncommutative geometry on trees and buildings* (with Gunther Cornelissen, Kamran Reihani and Alina Vdovina), in "Traces in Geometry, Number Theory and Quantum Fields", pp. 73-98, Vieweg Verlag, 2007.

156. *From Physics to Number Theory via Noncommutative Geometry. Part II: Renormalization, the Riemann–Hilbert correspondence, and motivic Galois theory* (with Alain Connes), in "Frontiers in Number Theory Physics and Geometry, II", pp.617–713, Springer Verlag, 2006.

157. *KMS states and complex multiplication (part II)*, (with Alain Connes and Niranjan Ramachandran) in "Operator Algebras", pp.15–60, Springer Verlag, 2006.

158. *Modular curves, C^*-algebras, and chaotic cosmology*, in "Frontiers in Number Theory Physics and Geometry, II" pp.361–372, Springer Verlag, 2006.

159. *Archimedean cohomology revisited*, (with Caterina Consani), in "Noncommutative Geometry and Number Theory", pp.109–140. Vieweg Verlag, 2006.

160. *Towards the fractional quantum Hall effect: a noncommutative geometry perspective* (with Varghese Mathai) in "Noncommutative Geometry and Number Theory", pp.235–262. Vieweg Verlag, 2006.

161. *From Physics to Number Theory via Noncommutative Geometry. Part I: Quantum Statistical Mechanics of Q-lattices*, (with Alain Connes) in "Frontiers in Number Theory Physics and Geometry, I", pp.269–350, Springer Verlag, 2006.

162. *Variants of equivariant Seiberg-Witten Floer homology*, (with Bai-Ling Wang), in "Spectral Geometry of Manifolds with Boundary and Decomposition of Manifolds", Contemporary Mathematics, Vol. 366 (2005) 225–238.

163. *New perspectives in Arakelov geometry*, (with Caterina Consani), in "Number Theory", CRM Lecture Notes, Vol. 36 (2004) 81–102.

Preprints

164. *Old and New Minimalism: a Hopf algebra comparison* (with Robert Berwick and Noam Chomsky) arXiv:2306.10270

165. *Mathematical Structure of Syntactic Merge*, (with Noam Chomsky and Robert Berwick) arXiv:2305.18278

166. *Cohn-Elkies functions from Gabor frames*, (with Yuri I. Manin) arXiv:2212.06778

167. *Computability questions in the sphere packing problem*, (with Yuri I. Manin) arXiv:2212.05119

168. *Quantum SUSY operads* (with Noemie C. Combe and Yuri I.Manin) arXiv:2208.11629

169. *Pareto Optimization in Categories*, arXiv:2204.11931

170. *Categorical Hopfield Networks*, arXiv:2201.02756

171. *Syntactic structures and the general Markov models* (with Sitanshu Gakkhar) arXiv:2104.08462

172. *Quantum Statistical Mechanics and the Boundary of Modular Curves* (with Jane Panangaden) arXiv:2006.16897

173. *Homotopy Theoretic and Categorical Models of Neural Information Networks* (with Yuri I. Manin) arXiv:2006.15136

Other publications

Books edited

174. *Frobenius manifolds, quantum cohomology and singularities*, (with Claus Hertling, Editors), Vieweg Verlag, 2004.

175. *Noncommutative Geometry and Number Theory*, (with Caterina Consani, Editors), Vieweg Verlag 2006.

176. *Traces in Geometry, Number Theory and Quantum Fields*, (with Sergio Albeverio, Sylvie Paycha, Jorge Plazas), Vieweg Verlag 2007.

177. *An invitation to Noncommutative Geometry*, (with Masoud Khalkhali), World Scientific, 2008.

178. *Arithmetic and Geometry around Quantization*, (with Özgür Ceyhan and Yuri Manin), Birkhäuser (to appear in 2009).

179. *Deformation Spaces*, (with Hossein Abbaspour and Thomas Tradler), Vieweg Verlag (to appear in 2010).

180. *Quantum groups and noncommutative geometry*, (with Deepak Parashar) Vieweg Verlag (to appear in 2010).

181. *Combinatorics and Physics*, (with Kurusch Ebrahimi-Fard and Walter van Suijlekom) Contemporary Mathematics, Vol.539, American Mathematical Society, 2011.

Popularization and other non-refereed publications

182. *A drifter of Dadaist persuasion*, in "Art in the Lives of Mathematicians" (Editor: Anna Kepes Szemeredi), pp. 223–244, American Mathematical Society, 2015.

183. *The Wolf and the Street: narrative encounters with Mathematics*, in "Imagine Math 3" (Editor: Michele Emmer) pp. 225–234, Springer Verlag, 2015.

184. *Mathematics as culture and knowledge*, in "Les Dechiffreurs", Belin 2008.

185. *Noncommutative geometry and number theory*, in Nieuw Archief voor Wiskunde, (5) 9 (2008), no. 2, 109–112.

186. *Number theory in physics*, invited contribution to the "Encyclopaedia of Mathematical Physics" Elsevier.

Older unpublished manuscripts

187. *Dynamical systems on spectral metric spaces* (with Jean Bellissard and Kamran Reihani), arXiv:1008.4617

188. *Anomalies, Dimensional Regularization, and Noncommutative Geometry* (with Alain Connes), unfinished, available at
`http://www.its.caltech.edu/~matilde/anomalies.pdf`

189. *Exact triangles in Seiberg-Witten-Floer theory, Part II: geometric limits of flow lines*, (with Bai-Ling Wang)

    arXiv:math.DG/9907080 71 pages

190. *Exact triangles in Seiberg-Witten-Floer theory, Part III: the proof of exactness*, (with Bai-Ling Wang)

    arXiv:math.DG/0009157. 69 pages

191. *Exact triangles in Seiberg–Witten Floer theory. Part IV: Z-graded monopole homology*, (with Bai-Ling Wang)

arXiv:math.DG/0009159. 34 pages

192. Система Обыкновенниих Дифференциальних Уравнений Антисамодвойственних Связностей и Монополей Дирака,

MPI preprints 2002-40. 7 pages

Mathematical Activities

Regarding lectures and conferences: for more than a decade, starting in 2009, I have implemented a strict policy of declining almost all conference invitations and avoiding as much as possible giving lectures and seminar talks. I plan to continue implementing these restrictions in the future. The lectures and conference activities listed below are the rare exceptions to this general policy.

Invited Lecture Series

- April 2018: Lecture Series on Mathematical Linguistics (Mathematics Colloquium, Linguistics Colloquium, Complex Systems Seminar) University of Utrecht, The Netherlands
- May 2015: three lectures at the "Geometry and Physics 2015" conference, Perimeter Institute for Theoretical Physics, Canada.
- July 2014: ten lectures and the Clay Institute Summer School "Periods and Motives: Feynman amplitudes in the 21st century", ICMAT Madrid, Spain
- July 2013: four lectures at the program "Mathematical Methods from Physics", Kavli Institute for Theoretical Physics China, and Morningside Center, Beijing
- July 2011: five lectures at "Geometry and Quantum Field Theory" school, Villa de Leyva, Colombia.
- February 2011: three lectures at Perimeter Institute for Theoretical Physics

- January 2011: Jose Adem Memorial Lecture Series, Cinvestav, Mexico City

- April 2010: Series of three lectures, "Noncommutative geometry, Number Theory and Mathematical Physics", Unam, Cuernavaca, Mexico

- June 2010: Minicourse on Arithmetic Noncommutative Geometry in the Master Class "Arithmetic Geometry and Noncommutative Geometry" Utrecht University, The Netherlands.

- January–March 2008: Graduate Course "Noncommutative Geometry", Florida State University, USA.

- November 2007: Two lectures mini-course at *États de la Recherche: Géométrie Noncommutative*, CNRS Metz, France.

- June 2006: Two lectures in the school/workshop "Arithmetic and Geometry around Quantization", Istanbul, Turkey.

- May 2006: Three lectures at the Spring School on Noncommutative Geometry and Operator Algebras, Vanderbilt University, USA.

- November 2005: Two lectures in the program "Mathematical structures of String Theory", Kavli Institute for Theoretical Physics, USA.

- October 2005: Series of two lectures at the workshop "Symmetry and universality in mesoscopic systems" Bad Honnef Physics Center, Germany.

- September 2005: Series of three lectures at the school/workshop "NCG 2005" at IPM Tehran, Iran.

- May 2005: "Kempf Lectures", Johns Hopkins University, USA.

- April 2005: Lecture Series (jointly with Alain Connes) at Vanderbilt University, USA.

- April 2005: Three lectures at the "Masters Forum: Noncommutative Geometry" Fudan University, Shanghai, PR China.

- December 2004: Three lectures at the Banach Center, Polish Academy of Science and Warsaw University, Poland.

- October 2004: Two lectures at the workshop "Noncommutative Manifolds", ISAS/SISSA and ICTP, Trieste, Italy.
- May 2004: Series of five lectures on "Noncommutative and arithmetic geometry" at the Spring School on Noncommutative Geometry and Operator Algebras, Vanderbilt University, USA.
- February 2004: Series of four lectures on "Noncommutative Geometry and Number Theory", CIRM Luminy, France, Meeting: Noncommutative Geometry in Mathematics and Physics.
- February 2003: Series of five lectures on "Noncommutative and arithmetic geometry", University of Nottingham, UK
- October 2002: Series of four lectures on Noncommutative geometry, Fields Institute, Toronto, Canada.

Conference and Seminar Talks

- June 2023: Theoretical Linguistics Seminar, Utrecht University: "A mathematical model of syntactic Merge"
- February 2023: closing lecture of Manin's Seminar "Algebra, Geometry, and Physics", MPI Bonn: "The Last Lecture: Computability Questions in the Sphere Packing Problem"
- July 2021: Geometric Science of Information, Sorbonne, Paris: Topological Models of Neural Information Networks
- June 2020(2021): Plenary Lecture at the Canadian Mathematical Society 75th Anniversary Summer Meeting: Entropy, holography, and p-adic geometry
- May 2021: Hot Topics: Topological Insights in Neuroscience, Mathematical Sciences Research Institute (MSRI), Berkeley, workshop lecture: Homotopy Theoretic and Categorical Models of Neural Information Networks
- March 2020: Focus Program on New Geometric Methods in Neuroscience, Fields Institute, Toronto, Canada, workshop lecture: Homotopy Theory and Neural Information Networks

- January 2020: Joint Mathematical Meeting American Mathematical Society, Special Session on Singularities and Characteristic Classes, Denver, US, invited lecture: Motives of intersections of quadrics and the Feynman integral of the massive sunset graph
- October 2019: Conference "Michael Atiyah – Forays into Physics", Newton Institute, Cambridge UK, invited lecture: Anyons, networks, and codes in geometric models of matter
- August 2019: New Geometries of Quantum Dynamics, Fields Institute, Canada, invited lecture: Spectral gravity models on multifractal Robertson-Walker cosmologies
- July 2019: MOL 2019 – The 16th Meeting on the Mathematics of Language, invited plenary speaker, University of Toronto, Canada
- March 2019: Session on Algebraic and Combinatorial Structures in Knot Theory, AMS Meeting, University of Hawaii, USA
- March 2019: Session on Combinatorial and Experimental Methods in Mathematical Phylogeny, AMS Meeting, University of Hawaii, USA
- March 2019: Session on Coding Theory and Information Theory, AMS Meeting, University of Hawaii, USA
- March 2019: Session on Geometry, Analysis, Dynamics and Mathematical Physics on Fractal Spaces, AMS Meeting, University of Hawaii, USA
- March 2019: Session on Number Theory, Commutative Algebra and Algebraic Geometry, AMS Meeting, University of Hawaii, USA
- November 2018: LanGeLin Linguistics Workshop, York University, UK
- October 2018: F-theory Workshop, Harvard University
- August 2018: Higher Algebra and Mathematical Physics, Perimeter Institute, Canada
- February 2018: Cosmology Seminar, Perimeter Institute, Canada
- November 2017: Geometric Structures of Information, Paris, France

- August 2017: Geometrical and Topological Structures of Information, CIRM Luminy, France
- June 2017: Arbeitstagung, Manin's 80th Birthday Conference, Bonn, Germany
- October 2016: invited speaker at "NSF Workshop: Geometry for Signal Processing and Machine Learning", Estes Park, Colorado, USA
- May 2016: invited speaker at "Phylogenetic Models: Linguistics, Computation, and Biology", MIT, Cambridge, USA
- March 2016: Plenary talk at "1st International Symposium on the Physics of Language", Tokyo, Japan
- October 2015: Opening plenary lecture at the "2nd conference on Geometric Science of Information", École Polytechnique, Paris, France
- October 2015: Sectional talk at '2nd conference on Geometric Science of Information", École Polytechnique, Paris, France
- April 2015: Cosmology Seminar, Perimeter Institute for Theoretical Physics, Canada
- December 2014: Seminar of Algebra, Geometry and Physics, Max Planck Institute for Mathematics, Bonn
- August 2014: Cosmology Seminar, Perimeter Institute for Theoretical Physics, Waterloo, Canada
- June 2014: plenary talk, "String-Math 2014", University of Alberta, Edmonton, Canada
- April 2014: Noncommutative Geometry Seminar, Texas A&M
- April 2014: Topology Seminar, MIT
- March 2014: talk at Special Session "Singularities and Physics", AMS meeting, Knoxville
- February 2014: plenary talk at the 32nd Annual Western States Mathematical Physics Meeting

- December 2013: Seminar of Algebra, Geometry and Physics, Max Planck Institute for Mathematics, Bonn
- November 2013, Plenary lecture, AMS Sectional Meeting, UC Riverside
- November 2013, talk in the special session "Fractal Geometry" at the AMS Sectional Meeting, UC Riverside.
- July 2013, invited lecture at Tsinghua University Institute for Advanced Study, Beijing.
- July 2013, invited lecture at Beijing International Center for Mathematical Research, Beijing University.
- May 2013, lecture at the conference "Hodge Theory and Classical Algebraic Geometry" for Herb Clemens, Ohio State University
- April 2013, MSRI-Evans Lecture, Berkeley
- April 2013, talk at the workshop "Geometric perspectives in mathematical quantum field theory", AIM, Palo Alto
- January 2013, two lectures at the opening workshop of the program "Noncommutative Algebraic Geometry and Representation Theory", MSRI, Berkeley.
- January 2013, lecture at "AlbertoFest" conference in honor of the 70th birthday of Alberto Verjovksy, UNAM Cuernavaca, Mexico
- October 2012, "West Coast Operator Algebra Seminar", University of Oregon
- June 2012, talk in the conference "Fractal Geometry and Dynamical Systems", UC Riverside
- April 2012, talk at the "Midwest Topology Seminar", Purdue University
- April 2012, two lectures in the workshop "Novel approaches to the finite simple groups", Banff, Canada

- March 2012, talk in the workshop "Noncommutative Algebraic Geometry and its Applications to Physics", Lorentz Center, Leiden, The Netherlands
- March 2012, Colloquium Talk, University of Hawaii at Manoa
- June 2011: plenary talk Strings-Math conference, U Penn
- March 2011: Colloquium, Harvard University
- January 2011: AMS National Meeting New Orleans, Session on "Mathematics Related to Feynman Diagrams"
- November 2010: AMS meeting Notre Dame, Section "Number Theory and Physics".
- August 2010: Section "Mathematical Physics", ICM 2010, Hyderabad, India.
- June 2010: Workshop "Geometry and Quantum Field Theory", MPI Bonn, Germany.
- April 2010: Colloquium talk Georgiatech, Atlanta, USA.
- February 2010: Workshop "Noncommutative Geometry and Loop Quantum Gravity", Oberwolfach, Germany
- December 2009: Meeting "Noncommutative Geometry and Cosmology", IHES, Paris, France.
- November 2009: AMS Special Session "Algebraic Geometry", UC Riverside, USA.
- November 2009: AMS Special Session "Noncommutative Geometry", UC Riverside, USA.
- October 2009: Geometry and Physics Seminar, Northwestern University, USA.
- September 2009: High Energy Physics Seminar, Florida State University, USA.
- September 2009: Algebra Seminar, Florida State University, USA.

- July 2009: Seminar Algebra Geometry and Physics, MPI, Bonn, Germany.
- July 2009: Conference "Noncommutative geometric methods in global analysis", Hausdorff Center, Bonn, Germany.
- June 2009: Workshop "Quantum fields, periods and polylogarithms", IHES, Paris.
- May 2009: Conference "Geometry over F1, noncommutative geometry, and zeta", Vanderbilt University, USA.
- March 2009: JAMI conference, Johns Hopkins University, Baltimore, USA.
- March 2009: Algebraic Geometry Seminar, MSRI, USA.
- March 2009: Colloquium, U Michigan, Ann Arbor, USA.
- March 2009: Geometry and Physics Seminar, U Michigan, Ann Arbor, USA.
- February 2009: Mathematical Physics Meeting, Caltech, USA.
- February 2009: Symplectic Geometry Seminar, UC Berkeley.
- October 2008: Colloquium, University of Southern California, USA
- September 2008: Colloquium, UCLA, USA.
- January 2008: Workshop "Random matrices and number theory", Hausdorff Institute for Mathematics, Bonn, Germany.
- December 2007: Colloquium, Caltech, USA.
- December 2007: Mathematical Physics Seminar, Caltech, USA.
- November 2007: Conference "Noncommutative Manifolds", ICTP, Trieste, Italy.
- October 2007: Colloquium, Yale University, USA.
- October 2007: Mathematical Physics Seminar, Yale University, USA.

- October 2007: Symplectic Geometry Seminar, Courant Institute, NYU, USA.
- October 2007: Special Section "Noncommutative Geometry and Arithmetic", Sectional AMS meeting, New Brunswick, USA.
- June 2007: Euler Fest, "Arithmetic Geometry" Conference, St. Petersburg, Russia.
- May 2007: Workshop "Trends in Noncommutative Geometry", Northwestern University, USA.
- May 2007: Spring School on Noncommutative Geometry and Operator Algebras, Vanderbilt University, USA.
- March 2007: Colloquium Berkeley, USA.
- March 2007: Number Theory Seminar, Berkeley, USA.
- February 2007: Centre Physique Théoretique, Luminy Marseille, France.
- February 2007: Colloquium "Geometry and Quantum Physics Cluster", Nijmegen, The Netherlands.
- January 2007: Workshop "Motives in Physics" MPIMIS Leipzig, Germany.
- December 2006: Talk in the workshop "Renormalization", MPIM Bonn.
- October 2006: Colloquium, University of Rome II, Italy.
- July 2006: Colloquium, Freiburg University, Germany.
- May 2006: Talk in the workshop "Characteristic classes of singular spaces" Renyi Institute, Budapest, Hungary.
- May 2006: Centre Physique Théoretique, Luminy Marseille, France.
- April 2006: Noncommutative Geometry Conference, Banff, Canada.
- March 2006: Operator Algebra Seminar, University of Oslo, Norway.
- March 2006: Operator Algebra Seminar, University of Trondheim, Norway.

- March 2006: Colloquium, University of Trondheim, Norway.
- February 2006: Mathematical Sciences Institute, Australian National University, Canberra, Australia.
- September 2005: Department of Mathematics, University of Milan, Italy.
- September 2005: Talk at the workshop "Arithmetic geometry and high energy physics", Lorentz Center, Leiden, The Netherlands.
- June 2005: Workshop on Renormalization and Number Theory, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany.
- June 2005: Lecture at Arbeitstagung, MPI Bonn, Germany.
- June 2005: Lecture in the "Giornata INdAM", Neaples, Italy.
- May 2005: The 3rd Annual Spring Institute on Noncommutative Geometry and Operator Algebras, Vanderbilt, USA
- February 2005: Centre de Physique Théorique, Luminy, France
- February 2005: Lecture in the "Journée thematique: géométrie complexe théorie de jauge", Institut de Mathématiques de Luminy, France
- October 2004: Mathematical Physics Seminar, ETH Zurich, Switzerland
- September 2004: Noncommutative Geometry conference, Oberwolfach, Germany
- September 2004: Lecture in the First Abel Symposium "Operator Algebras", Oslo, Norway
- March 2004: Seminar Algebraic Structures in Quantum Field Theory, Florida State University, USA
- March 2004: Algebra Seminar, Florida State University, USA
- February 2004: special lecture on gauge theory on 3-manifolds, meeting "Noncommutative Geometry in Mathematics and Physics", CIRM Luminy, France.

- January 2004: Geometric Analysis Seminar, Laboratoire Emile Picard, Université Paul Sabatier, Toulouse, France.
- January 2004: Stochastics Seminar, University of Bonn, Germany.
- January 2004: Opening Lecture at the workshop "Arithmetic and algebraic geometry", University of Padua, Italy.
- November 2003: Algebra Seminar, Florida State University, USA.
- October 2003: Lecture at the workshop "Geometry and Physics" CIRM Luminy, France.
- September 2003: Lecture at the workshop "Noncommutative Geometry", Mittag–Leffler Institute, Stockholm, Sweden.
- August 2003: Lecture at the "Workshop on Noncommutative geometry and Number Theory", MPI Bonn, Germany
- June 2003: Lecture at Arbeitstagung, MPI Bonn, Germany.
- May 2003: Number Theory Seminar, University of Utrecht, the Netherlands.
- March 2003: Lecture at the Les Houches school "Frontiers in Number Theory, Physics, and Geometry", France.
- February 2003: Cambridge-Oxford-Warwick Seminar in Algebraic Geometry, UK.
- February 2003: Colloquim Lecture, University of California Berkeley, USA.
- January 2003: Lecture at the AMS National meeting, special session "Computational algebraic and analytic geometry for low dimensional varieties", Baltimore USA.
- January 2003: Lecture at the AMS National meeting, special session "Primes and knots", Baltimore USA.
- December 2002: Geometric Mathematical Physics Seminar, Aarhus University, Denmark.

- December 2002: Topology Seminar, Aarhus University, Denmark.
- November 2002: Lecture at the session "manifolds in mathematics and other fields" of the meeting "Art and Science in Europe" of the Polish Academy of Science and the Max–Planck Society, Warsaw, Poland.
- October 2002: Colloquium Lecture, University of Toronto, Canada.
- October 2002: Colloquium Lecture, Florida State University, USA.
- September 2002: Opening Lecture at the conference "Geometric properties of real and complex manifolds", Palermo, Italy.
- July 2002: Lecture at the workshop "Geometrical aspects of field equations", Greifswald, Germany.
- June 2002: Algebraic Geometry Seminar, Université de Rennes I, France.
- May 2002: Colloquium Lecture, Münster University, Germany.
- January 2002: Roskilde University, Denmark.
- November 2001: Number Theory Seminar, MPIM Bonn, Germany.
- November 2001: Algebraic Geometry seminar, University of Toronto, Canada.
- November 2001: Colloquium Lecture, Regensburg University, Germany.
- October 2001: University of Helsinki, Finland.
- October 2001: Seminar on Algebra, Geometry and Physics, MPIM Bonn, Germany.
- August 2001: Lecture at the workshop "Topology of manifolds and group actions", CRM Montreal, Canada.
- May 2001: Scuola Normale Superiore, Pisa, Italy.
- May 2001: Colloquium Lecture, Bielefeld University, Germany.
- May 2001: Colloquium Lecture, Bonn University, Germany.

- March 2001: Lecture at the conference "Geometric Analysis and Index Theory", ICTP Trieste, Italy.
- February 2001: Colloquium Lecture, Göttingen University, Germany.
- January 2001: Differential Geometry Seminar, Bonn University, Germany.
- November 2000: Topology seminar, Trinity College, Dublin, Ireland.
- November 2000: Lecture at the conference "Perspectives in geometry", Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany.
- August 2000: Seminar on Algebra, Geometry and Physics, MPIM Bonn, Germany.
- June 2000: Lecture at the EURESCO conference "Mathematical Analysis", Castelvecchio Pascoli, Italy.
- May 2000: Two lectures at the conference "Perspectives in gauge theory and calibrated geometry", Martina Franca, Italy.
- February 2000: Gauge Theory Seminar, Harvard University, USA.
- November 1999: Mathematical Physics Seminar, Harvard University/MIT, USA.
- October 1999: Topology seminar, Yale University, USA.
- October 1999: Geometry seminar, University of Illinois at Urbana Champaign, USA.
- October 1999: Lecture at the sectional AMS meeting, Special Session "Gauge Theory", Charlotte NC, USA.
- October 1999: Lecture at the sectional AMS meeting, Special Session "Index theory", Austin, USA.
- August 1999: Opening Lecture at the Conference "Geometric properties of real and complex manifolds", Palermo, Italy.

- June 1999: Oberseminar Topologie, Max Planck Institut für Mathematik, Bonn, Germany.
- March 1999: Geometry Seminar, Florida State University, USA.
- January 1999: Tata Institute of Fundamental Research, Mumbai, India.
- July 1998: Oberseminar Topologie, Max Planck Institut für Mathematik, Bonn, Germany.
- January 1998: Stanford University, USA.
- December 1997: Lecture at the Joint Meeting of the Mexican Mathematical Society and of the American Mathematical Society, Oaxaca, Mexico.
- November 1997: Ohio State University, USA.
- July 1997: Lecture at the Topical Workshop in Geometry and Physics, Center for the Subatomic Structure of Matter, University of Adelaide, Australia.
- April 1997: University of Adelaide, Australia.
- January 1997: Lecture at the Workshop on 4-dimensional manifolds, MSRI, USA.
- May 1996: Stanford University, USA.
- December 1995: University of Bielefeld, Germany.
- September 1993: Lecture at the International Conference of Topology, Trieste Italy.
- May 1992: Lecture at the Workshop on Measure Theory and Real Analysis, Grado Italy.

Conferences organized

1. Organizer of Semester Program "Math + Neuroscience: Strengthening the Interplay Between Theory and Mathematics", ICERM Brown University, September 6 – December 8, 2023

2. Main organizer of the "Focus Program on New Geometric Methods in Neuroscience", Fields Institute, Canada, February 24 – March 13, 2020

3. Conference "Geometrical and topological structures of information", CIRM Luminy, France, August 2017.

4. Workshop "Algebraic and Geometric Deformation Spaces", Bonn August 11-15, 2008 (co-organized with Hossein Abbaspour and Thomas Tradler).

5. Workshop "The manifold geometries of quantum field theory", Bonn June 30-July 4, 2008 (co-organized with Sergio Albeverio and Hanno Gottschalk).

6. Winter School and Workshop "Moduli Spaces" MPI and Bonn University, January 2-11, 2008 (co-organized with C.F.Bödigheimer, Yu.I.Manin, U.Tillmann).

7. International School and Conference of Noncommutative Geometry, Chern Institute Nankai University, Tianjin, PR China August 15-30, 2007. (co-organized with Guihua Gong and Guoliang Yu).

8. Workshop "Quantum Groups and Noncommutative Geometry", MPIM Bonn, August 6-8, 2007 (co-organized with Deepak Parashar).

9. Workshop "Hochschild and Cyclic (co-)homology and Applications to Geometry and Physics" MPIM Bonn, July 16-19, 2007 (co-organized with Hossein Abbaspour).

10. Alain Connes 60th birthday conference IHES/IHP March 29-April 6, 2007 (co-organized with Henri Moscovici and Georges Skandalis)

11. Workshop "Combinatorics and Physics" MPIM Bonn, March 2007. (co-organized with Kurusch Ebrahimi-Fard and Walter van Suijlekom)

12. Workshop "Renormalization", MPIM Bonn, December 15–16, 2006. (co-organized with Kurusch Ebrahimi-Fard)

13. "Fourth Annual Spring Institute on Noncommutative Geometry and Operator Algebras", Vanderbilt University, May 8–17, 2006. (co–organized with Dietmar Bisch, Alain Connes, Bruce Hughes, Gennadi Kasparov, and Guoliang Yu).

14. "Traces in Geometry, Number Theory, and Quantum Fields", MPIM September 28-October 7, 2005. (co–organized with Sergio Albeverio, Sylvie Paycha)

15. "International workshop on Noncommutative Geometry", school and workshop, IPM Tehran, Iran, September 11-22, 2005 (co–organized with Masoud Khalkhali, Shahin S. Jabbari, Mehrdad Mirshams Shahshahani).

16. "Arithmetic Geometry and High Energy Physics", Lorenz Center, Leiden, the Netherlands, August 29-September 2, 2005 (co–organized with Gunther Cornelissen and Andrew Waldron).

17. "Yuri Manin's Emeritierung Conference", MPIM Bonn February 24-26, 2005 (co–organized with Ivan Penkov and Don Zagier).

18. "Workshop on Noncommutative geometry and Number Theory, II", MPI June 14-18, 2004 (co–organized with A.Connes, C.Consani, and Yu.Manin).

19. "Workshop on Noncommutative geometry and Number Theory", MPI August 17-22, 2003 (co–organized with C.Consani and Yu.Manin).

20. "Frobenius manifolds, singularities, and quantum cohomology", MPI July 8-19, 2002 (co–organized with B. Dubrovin, C. Hertling, Yu. Manin, K. Saito).

21. "Maass wave forms, Selberg zeta function, and Spin chains" MPI June 10-14, 2002 (co–organized with J. Lewis and D. Zagier).

Students currently or previously supervised

Former students:

- Eugene Ha (PhD 2006) "Quantum Statistical Mechanics of Shimura varieties"
- Jorge Plazas Vargas (PhD 2007) "Arithmetic structures on noncommutative tori with real multiplication"
- Snigdhayan Mahanta (PhD 2007)"Algebraic aspects of Noncommutative Tori: the Riemann–Hilbert correspondence"
- Ivan Dynov (PhD 2008) "Type III von Neumann Algebras in the Theory of Infinite-Dimensional Groups".
- Ahmed Zainy al-Yasry (PhD 2008) "Coverings, Correspondences, and Noncommutative Geometry".
- Bram Mesland (PhD 2009) "Bivariant K-theory of Groupoids and the Noncommutative Geometry of Limit Sets".
- Rafael Torres (PhD 2010) "Geography and Botany of Irreducible Symplectic 4-manifolds with Abelian Fundamental Group"
- Ali Shojaei-Fard (PhD 2010) "Riemann-Hilbert Problem and Quantum Field Theory: Integrable Renormalization, Dyson-Schwinger Equations".
- Majid Heydarpour (PhD 2010) "Green Functions on the Boundary at Infinity of Hyperbolic 3-manifolds"
- Tobias Fritz (PhD 2010) "Contributions to Quantum Probability"
- Dapeng Zhang (PhD 2011) "Projective Dirac operators, twisted K-theory and local index formula"
- Nikolay Ivankov (PhD 2011) "Unbounded bivariant K-theory and an approach to noncommutative Frechet spaces"
- Dan Li (PhD 2012) "Periods and motives: applications in Mathematical Physics"

- Christopher Duston (PhD 2012) "Exotic smoothness, branched covering spaces and quantum gravity"
- Branimir Ćaćić (PhD 2013) "On reconstruction theorems in noncommutative Riemannian geometry"
- Kevin Teh (PhD 2013) "Dirac spectra, summation formulae, and the spectral action"
- Victor Kasatkin (PhD 2015) "Some constructions related to noncommutative tori, Fredholm modules and the Beilinson-Bloch regulator"
- Shane Farnsworth (PhD 2015) "Standard model physics and beyond from non-commutative geometry"
- Xiang Ni (PhD 2016) "Rota-Baxter Algebras, Renormalization on Kausz Compactifications and Replicating of Binary Operads"
- Emad Nasrollahpoursamani (PhD 2017) "Periods of Feynman Integrals"
- Yunyi Shen (PhD 2017) "Arithmetic Aspects of Noncommutative Geometry: Motives of Noncommutative Tori and Phase Transitions on GL(n) and Shimura Varieties Systems"
- James Tao (PhD 2019) "Analysis on Vector Bundles over Noncommutative Tori"
- Matthew Heydeman (PhD 2019) "Supersymmetric Scattering Amplitudes and Algebraic Aspects of Holography from the Projective Line"
- Joshua Leiber (PhD 2021) "Études in homotopical thinking: F_1-geometry, concurrent computing, and motivic measures"
- Thomas Norton (PhD 2021) "Discrete Deligne Cohomology and Discretized Abelian Chern-Simons Theory"
- Jane Panangaden (PhD 2022) "Quantum statistical mechanics, noncommutative geometry, and the boundary of modular curves"

Current PhD students:

- Ismail Abouamal (Caltech)
- Sitanshu Gakkhar (Caltech)
- Eliott Gesteau (Caltech)
- Pedro Guicardi (Caltech)
- Vasiliki Liontou (University of Toronto)

Teaching Experience

Courses taught:

- Geometry of Neuroscience (Caltech 2017, University of Toronto 2018)
- Mathematical and Computational Linguistics (Caltech 2015, University of Toronto 2019)
- Geometry and Physics of Information Theory (Caltech 2014, 2016, 2017, 2021)
- The Geometry of Quantum States (Caltech 2012)
- Motives and Quantum Field Theory (Caltech 2014, 2022)
- Motives and Periods (Caltech 2014)
- Quantum Statistical Mechanics in Number Theory (Caltech 2016)
- Arithmetic and Geometry of Quantum Fields (Caltech 2008)
- Noncommutative Geometry (Florida State University 2008, Caltech 2009, 2011, University of Toronto 2019)
- Noncommutative Geometry Models for Particle Physics and Cosmology (Caltech 2016, 2021)
- Chaos Theory and Fractal Geometry (Caltech 2011, 2014, 2017, University of Toronto 2020)

- Analysis on manifolds (MIT 1999)
- Calculus (University of Chicago, 1995, 1996, 1997, Caltech 2011)
- Topology (MIT 1998, Caltech 2017, 2021)
- Morse theory and Floer theory (MIT 1998)
- Differential Equations (Caltech 2010, 2012, 2014)
- Differential Geometry (MIT 2000)
- Riemann Surfaces (MIT 2000)
- Sanskrit for Modern Scientists (Caltech 2011)