

Curriculum Vitae  
List of Publications

Matilde Marcolli

2020

**Citizenship:** USA and Italy

**Work Addresses:**

- **(on leave from January 2018 through July 2020)**

Department of Mathematics  
California Institute of Technology (Caltech)  
1200 East California Boulevard  
Pasadena, CA 91125, USA  
email: matilde@caltech.edu

- **(from January 2018 through July 2020)**

Department of Mathematics  
University of Toronto  
Bahen Centre  
40 St George Street  
Toronto, ON, M5S 2E4, Canada  
matilde@math.utoronto.ca

- **(from January 2018 through July 2020)**

Perimeter Institute for Theoretical Physics  
31 Caroline Street North,  
Waterloo, ON, N2L 2Y5, Canada  
mmarcolli@perimeterinstitute.ca

**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

- 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.

### Scientific Awards

- **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)

- **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

- **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.
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. *Quantum Statistical Mechanics of the Absolute Galois Group* (with Yuri Manin) SIGMA 16 (2020), 038, 52 pages.
8. *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.
9. *Nori diagrams and persistent homology* (with Yuri Manin) Mathematics in Computer Science, 14 (2020) N.1, 77–102.
10. *Holographic Codes on Bruhat–Tits buildings and Drinfeld Symmetric Spaces*, Pure and Applied Mathematics Quarterly, Vol. 16 (2020), No. 1, 1–33.
11. *Adinkras, Dessins, Origami, and Supersymmetry Spectral Triples* (with Nick Zolman), p-Adic Numbers, Ultrametric Analysis and Applications, Vol.11 (2019), N.3, 223–247.



12. *Asymptotic bounds for spherical codes* (with Yuri Manin) Izvestiya Mat. 83 (2019) N.3, 117–141.
13. *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]
14. *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]
15. *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]
16. *Motivic Information*, Boll. Unione Mat. Ital., Vol.12 (2019) N.1-2, 19–41.
17. *Gamma Spaces and Information*, Journal of Geometry and Physics, 140 (2019) 26–55.
18. *Feynman quadrics-motive of the massive sunset graph* (with Goncalo Tabuada) J. Number Theory 195 (2019), 159–183
19. *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.
20. *Motives and periods in Bianchi IX gravity models* (with Wentao Fan, Farzad Fathizadeh) Lett. Math. Phys. 108 (2018), no. 12, 2729–2747.
21. *Some remarks concerning Voevodsky’s nilpotence conjecture* (with Marcello Bernardara, Goncalo Tabuada) J. Reine Angew. Math. 738 (2018) 299–312
22. *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.

23. *Periods and motives in the spectral action of Robertson-Walker spacetimes* (with F. Fathizadeh) *Comm. Math. Phys.* 356 (2017), no. 2, 641–671.
24. *Anyons in Geometric Models of Matter* (with Michael Atiyah) *J. High Energy Phys.* 2017, no. 7, 076, front matter+23 pp.
25. *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.
26. *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
27. *Spin Glass Models of Syntax and Language Evolution* (with Karthik Siva, Jim Tao) *Linguistic Analysis*, Vol.41 (2017) N.3-4, 559–608.
28. *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
29. *Bost-Connes systems, Categorification, Quantum Statistical Mechanics, and Weil Numbers* (with Goncalo Tabuada) *Journal of Noncommutative Geometry*, 11 (2017), no. 1, 1–49.
30.  *$q$ -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.
31. *Quantum statistical mechanics in arithmetic topology* (with Yujie Xu) *Journal of Geometry and Physics*, Vol. 114 (2017) 153–183.
32. *Syntactic Structures and Code Parameters* (with Kevin Shu) *Mathematics in Computer Science*, 11 (2017), no. 1, 79–90
33. *Spectral action gravity and cosmological models*, *Comptes Rendus Physique*, Vol. 18 (2017) N. 3–4, 226–234.
34. *Syntactic Parameters and a Coding Theory Perspective on Entropy and Complexity of Language Families*, *Entropy*, Vol.18 (2016) N.4, 17 pages

35. *Semantic Spaces* (with Yuri Manin) *Mathematics in Computer Science*, Vol.10 (2016) N.4, 459–477
36. *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.
37. *Spectral Action Models of Gravity on Packed Swiss Cheese Cosmology* (with Adam Ball) *Classical Quantum Gravity* 33 (2016), no. 11, 115018, 39 pages
38. *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.
39. *KMS weights on higher rank buildings* (with Jake Marcinek) *p-Adic Numbers Ultrametric Anal. Appl.* 8 (2016), no. 1, 45–67.
40. *Rota-Baxter algebras, singular hypersurfaces, and renormalization in Kausz compactifications* (with Xiang Ni), *Journal of Singularities*, Vol.15 (2016) 80–117.
41. *Locality of gravitational systems from entanglement of conformal field theories* (with Jennifer Lin, Hiroshi Ooguri, Bogdan Stoica) *Physical Review Letters*, 114 221601 (2015)  
(archive version “Tomography from Entanglement”, arXiv:1412.1879)
42. *From exceptional collections to motivic decompositions via noncommutative motives* (with Goncalo Tabuada) *J. Reine Angew. Math.* 701 (2015) 153–167.
43. *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.
44. *Graph Grammars, Insertion Lie Algebras, and Quantum Field Theory* (with Alex Port) *Math. Comput. Sci.* 9 (2015), no. 4, 391–408
45. *Potts models with magnetic field: arithmetic, geometry, and computation* (with Shival Dasu) *J. Geom. Phys.* 97 (2015), 14–24

46. *Entropy algebras and Birkhoff factorization* (with Nicolas Tedeschi) J. Geom. Phys. 97 (2015), 243–265
47. *Quantum computation and real multiplication* (with John Napp) Mathematics in Computer Science, 9 (2015), no. 1, 63–84.
48. *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.
49. *Algebraic renormalization and Feynman integrals in configuration spaces* (with Ozgur Ceyhan) Advances in Theoretical and Mathematical Physics, Vol.18 (2014) 469–511.
50. *Kolmogorov complexity and the asymptotic bound for error-correcting codes* (with Yuri Manin) Journal of Differential Geometry, Vol.97 (2014) 91–108.
51. *Big Bang, Blow up, and modular curves: algebraic geometry in cosmology* (with Yuri Manin) SIGMA 10 (2014), 073, 20 pages
52. *Noncommutative motives, numerical equivalence, and semi-simplicity* (with Goncalo Tabuada) American Journal of Mathematics, Vol.136 (2014) N.1, 59-75
53. *Noncommutative Artin motives* (with Goncalo Tabuada) Selecta Mathematica, Vol.20 (2014) N.1, 315-358.
54. *Jacobians of Noncommutative Motives* (with Goncalo Tabuada) Moscow Mathematical Journal, Vol.14 (2014) N.3, 577-594
55. *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
56. *Thermodynamic Semirings* (with Ryan Thorngren) Journal of Noncommutative Geometry, Vol.8 (2014) N.2, 337–392
57. *Endomotives of Toric Varieties* (with Zhaorong Jin) Journal of Geometry and Physics, Vol. 77 (2014) 48-71

58. *Gauge Networks in Noncommutative Geometry* (with Walter van Suijlekom) Journal of Geometry and Physics, Vol.75 (2014) 71-91
59. *Multifractals, Mumford curves, and Eternal Inflation* (with Nicolas Tedeschi) p-Adic Numbers, Ultrametric Analysis and Applications, Vol.6 (2014) N.2, 135-154.
60. *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.
61. *A motivic approach to phase transitions in Potts models* (with Paolo Aluffi) Journal of Geometry and Physics, Vol.63 (2013) 6–31.
62. *Graph reconstruction and quantum statistical mechanics* (with Gunther Cornelissen) Journal of Geometry and Physics, Vol.72 (2013) 110–117.
63. *Quantum field theory over  $F_1$*  (with Dori Bejleri) Journal of Geometry and Physics, 69 (2013) 40–59.
64. *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]
65. *Arithmetic of Potts model hypersurfaces* (with Jessica Su) International Journal of Geometric Methods in Modern Physics Vol. 10, No. 4 (2013) 1350005 [22 pages]
66. *Noncommutative Mixmaster cosmologies* (with Christopher Estrada) International Journal of Geometric Methods in Modern Physics, Vol.10 (2013) N.1 [28 pages]
67. *Kontsevich's noncommutative numerical motives* (with Goncalo Tabuada) Compositio Mathematica, Vol.148 (2012) N.6, 1811–1820.
68. *Feynman integrals and motives of configuration spaces* (with Ozgur Ceyhan) Communications in Mathematical Physics: Vol.313, N.1 (2012), Page 35–70.

69. *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.
70. *Codes as fractals and noncommutative spaces* (with Christopher Perez) Mathematics in Computer Science, Vol.6 (2012) N.3, 199–215.
71. *The Ricci flow on noncommutative two-tori* (with Tanvir Ahamed Bhuyain) Letters in Mathematical Physics, Vol.101 (2012) N.2, 173–194.
72. *The spectral action and cosmic topology* (with Elena Pierpaoli and Kevin Teh) Communications in Mathematical Physics, 304 (2011) 125–174.
73. *Graph hypersurfaces and a dichotomy in the Grothendieck ring* (with Paolo Aluffi) Letters in Mathematical Physics, (2011) Vol.95, 223–232.
74. *Error-correcting codes and phase transitions* (with Yuri Manin) Mathematics in Computer Science, Vol.5 (2011) 133-170.
75. *Cuntz-Krieger algebras and wavelets on fractals* (with Anna Maria Paolucci) Complex Analysis and Operator Theory, Vol.5 (2011) N.1, 41-81.
76. *Algebro-geometric Feynman rules* (with Paolo Aluffi), International Journal of Geometric Methods in Modern Physics, Vol.8 (2011) N.1, 203–237.
77. *Building cosmological models via noncommutative geometry*, International Journal of Geometric Methods in Modern Physics, Vol.8, N.5 (2011) 1131–1168.
78. *Early Universe models from Noncommutative Geometry* (with Elena Pierpaoli) Advances in Theoretical and Mathematical Physics, Vol.14 (2010) 1373–1432.
79. *Parametric Feynman integrals and determinant hypersurfaces* (with Paolo Aluffi) Advances in Theoretical and Mathematical Physics, Vol.14 (2010) 911-963.
80. *Spin foams and noncommutative geometry* (with Domenic Denicola and Ahmad Zainy al-Yasry) Class. Quantum Grav. 27 (2010) 205025 (53pp)

81. *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.
82. *Open string theory and planar algebras* (with Ozgur Ceyhan) J. Phys. A: Math. Theor. 43 (2010) 385401 (12pp)
83. *Cyclotomy and endomotives*, p-Adic Numbers, Ultrametric Analysis and Applications, Vol.1 (2009) N.3, 217-263.
84. *Feynman motives of banana graphs* (with Paolo Aluffi) Communications in Number Theory and Physics, Vol.3 (2009) N.1, 1-57.
85. *Fun with  $F_1$*  (with Alain Connes and Caterina Consani), Journal of Number Theory, Vol.129 (2009), N.6, 1532-1561.
86. *Solmanifolds and noncommutative tori with real multiplication*. Communications in Number Theory and Physics, Vol.2 (2008) No.2, 423–479.
87. *Supermanifolds from Feynman graphs*, (with Abhijnan Rej) Journal of Physics A, Vol.41 (2008) 315402 (21pp).
88. *Coverings, correspondences, and noncommutative geometry* (with Ahmed Zainy al-Yasry) Journal of Geometry and Physics, Vol.58 (2008) N.12, 1639-1661
89. *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.
90. *On the  $K$ -theory of graph  $C^*$  algebras* (with Gunther Cornelissen and Oliver Lorscheid) Acta Applicandae Mathematicae, Vol.102 (2008) N.1, 57–69.
91. *Noncommutative geometry and motives: the thermodynamics of endomotives*, (with Alain Connes and Caterina Consani), Advances in Mathematics, Vol.214 (2007) N.2, 761–831.
92. *Gravity and the Standard Model with neutrino mixing* (with Ali Chamseddine and Alain Connes), Advances in Theoretical and Mathematical Physics, 11 (2007) 991–1090.

93. *Quantum statistical mechanics over function fields* (with Caterina Consani) *Journal of Number Theory*, 123 (2007) 487–528.
94. *Quantum Fields and motives* (with Alain Connes), *Journal of Geometry and Physics*, Vol. 56 (2006) N.1, 55–85.
95. *Q-lattices: quantum statistical mechanics and Galois theory* (with Alain Connes), *Journal of Geometry and Physics*, Vol. 56 (2006) N.1, 2–23.
96. *KMS states and complex multiplication*, (with Alain Connes and Niranjan Ramachandran) *Selecta Math. (N.S.)* Vol.11 (2005) N.3-4, 325–347.
97. *Renormalization and motivic Galois theory* (with Alain Connes), *International Math. Research Notices* (2004) N.76, 4073–4092.
98. *Noncommutative geometry, dynamics, and  $\infty$ -adic Arakelov geometry*, (with Caterina Consani), *Selecta Mathematica*, Vol.10 (2004) N.2, 167–251.
99. *Spectral triples from Mumford curves*, (with Caterina Consani), *International Math. Research Notices*, 36 (2003) 1945–1972.
100. *Limiting Modular symbols and the Lyapunov spectrum*, *Journal of Number Theory*, Vol.98 N.2 (2003) 348–376.
101. *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.
102. *Triplets spectraux en geometrie d'Arakelov*, (with Caterina Consani), *Comptes Rendus Acad. Sci. Paris, Ser. I* 335 (2002) 779–784.
103. *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.
104. *Seiberg-Witten and Casson-Walker invariant for rational homology spheres*, (with Bai-Ling Wang) *Geometriae Dedicata*, Vol.91 (2002), 45–58.
105. *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)



106. *Holography principle and arithmetic of algebraic curves*, (with Yuri Manin), *Advances in Theoretical and Mathematical Physics*, Vol.5, N.3 (2001) 617-650.
107. *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)
108. *Twisted index theory on good orbifolds II: Fractional quantum numbers*, (with Varghese Mathai), *Communications in Mathematical Physics*, Vol.217 (2001) N.1 55–87.
109. *Twisted index theory on good orbifolds I: Noncommutative Bloch theory*, (with Varghese Mathai), *Communications in Contemporary Mathematics*, Vol.1 (1999) N.4, 553–587.
110. *Gauge groups and characteristic classes*, (with Mauro Spreafico), *Expositiones Mathematicae*, Vol.15 (1997) N.3, 229–249.
111. *Seiberg–Witten Floer homology and Heegaard splittings*, *International Journal of Mathematics*, 7 (1996) N.5, 671–696.
112. *Some remarks on conjugacy classes of bundle gauge groups*, *Cahiers Topologie Géom. Différentielle Catég.* 37 (1996) N.1, 21–39.
113. *Lorentz bundles*, *Rend. Inst. Mat. Univ. Trieste* 25 (1993) N.1-2, 309–315.

## Refereed Book Chapters/Volume Contributions

114. *Aspects of  $p$ -adic geometry related to entanglement entropy* to appear in “Integrability, Quantization, and Geometry – Dubrovin memorial volume” (Edited by: I. Krichever, S. Novikov, O. Ogievetsky and S. Shlosman) *Proceedings of Symposia in Pure Mathematics*, American Mathematical Society
115. *Homotopy types and geometries below  $\text{Spec}(Z)$*  (with Yuri Manin) in “Dynamics: Topology and Numbers”, pp. 27–56, *Contemporary Mathematics*, Vol. 744, American Mathematical Society, 2020.

116. *Feynman integrals and periods in configuration spaces* (with Ozgur Ceyhan), to appear in “Periods and Motives: Feynman amplitudes in the 21st century”, Clay Mathematical Institute and American Mathematical Society.
117. *Syntactic Phylogenetic Trees* (with Kevin Shu, Sharjeel Aziz, Vy-Luan Huynh, David Warrick) in “Foundations of Mathematics and Physics one Century after Hilbert” (Joseph Kounieher, Ed.) Springer Verlag, 2018, pp. 417–441.
118. *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.
119. *Moduli Operad over  $F_1$*  (with Yuri Manin) in “Absolute arithmetic and  $F_1$  geometry” (K.Thas, Ed.), pp. 331–364, European Mathematical Society, 2016.
120. *Information algebras and their applications*, in “Geometric science of information”, pp. 271–276, Lecture Notes in Comput. Sci., 9389, Springer, Cham, 2015.
121. *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.
122. *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.
123. *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.

124. *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.
125. *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.
126. *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.
127. *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
128. *Noncommutative geometry and arithmetic* (ICM talk) Proceedings of the ICM-2010, Hyderabad, Vol.III, 2057-2077, World Scientific/Hindustan Book Agency, 2010.
129. *Feynman integrals and motives*, in “European Congress of Mathematics, Amsterdam 14-18 July 2008”, pp.293–332, European Mathematical Society, 2010.
130. *Motivic renormalization and singularities*, in “Quanta of Maths”, Clay Mathematics Institute, Vol.11 (2010) 409-458.
131. *The Weil proof and the geometry of the adèle 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.
132. *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.

133. *A walk in the noncommutative garden* (with Alain Connes) in "An invitation to Noncommutative Geometry", pp.1-128, World Scientific, 2008.
134. *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.
135. *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.
136. *KMS states and complex multiplication (part II)*, (with Alain Connes and Niranjana Ramachandran) in "Operator Algebras", pp.15–60, Springer Verlag, 2006.
137. *Modular curves,  $C^*$ -algebras, and chaotic cosmology*, in "Frontiers in Number Theory Physics and Geometry, II" pp.361–372, Springer Verlag, 2006.
138. *Archimedean cohomology revisited*, (with Caterina Consani), in "Noncommutative Geometry and Number Theory", pp.109–140. Vieweg Verlag, 2006.
139. *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.
140. *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.
141. *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.
142. *New perspectives in Arakelov geometry*, (with Caterina Consani), in "Number Theory", CRM Lecture Notes, Vol. 36 (2004) 81–102.

## Preprints

143. *Motives of melonic graphs* (with Paolo Aluffi and Waleed Qaisar) arXiv:2007.08565
144. *Quantum Statistical Mechanics and the Boundary of Modular Curves* (with Jane Panangaden) arXiv:2006.16897
145. *Homotopy Theoretic and Categorical Models of Neural Information Networks* (with Yuri I. Manin) arXiv:2006.15136
146. *Dessins for Modular Operad and Grothendieck-Teichmüller Group* (with Noemie C. Combe, Yuri I. Manin) arXiv:2006.13663
147. *Anyon Networks from Geometric Models of Matter* (with Michael Atiyah) invited submission to Quarterly Journal of Mathematics
148. *Topological Analysis of Syntactic Structures* (with Alexander Port and Taelin Karidi) arXiv:1903.05181
149. *Bost-Connes systems and F1-structures in Grothendieck rings, spectra, and Nori motives* (with Joshua F. Lieber, Yuri I. Manin) arXiv:1901.00020
150. *Nonarchimedean Holographic Entropy from Networks of Perfect Tensors* (with Matthew Heydeman, Sarthak Parikh, Ingmar Saberi) arXiv:1812.04057
151. *Heat Kernel analysis of Syntactic Structures* (with Andrew Ortegaray, Robert C. Berwick) arXiv:1803.09832
152. *Phylogenetics of Indo-European Language families via an Algebro-Geometric Analysis of their Syntactic Structures* (with Kevin Shu, Andrew Ortegaray, Robert C. Berwick) arXiv:1712.01719

## Other publications

### Books edited

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

154. *Noncommutative Geometry and Number Theory*, (with Caterina Con-  
sani, Editors), Vieweg Verlag 2006.
155. *Traces in Geometry, Number Theory and Quantum Fields*, (with Sergio  
Albeverio, Sylvie Paycha, Jorge Plazas), Vieweg Verlag 2007.
156. *An invitation to Noncommutative Geometry*, (with Masoud Khalkhali),  
World Scientific, 2008.
157. *Arithmetic and Geometry around Quantization*, (with Özgür Ceyhan  
and Yuri Manin), Birkhäuser (to appear in 2009).
158. *Deformation Spaces*, (with Hossein Abbaspour and Thomas Tradler),  
Vieweg Verlag (to appear in 2010).
159. *Quantum groups and noncommutative geometry*, (with Deepak Parashar)  
Vieweg Verlag (to appear in 2010).
160. *Combinatorics and Physics*, (with Kurusch Ebrahimi-Fard and Walter  
van Suijlekom) Contemporary Mathematics, Vol.539, American Math-  
ematical Society, 2011.

## Popularization and non-refereed publications

161. *A drifter of Dadaist persuasion*, in “Art in the Lives of Mathemati-  
cians” (Editor: Anna Kepes Szemerédi), pp. 223–244, American Math-  
ematical Society, 2015.
162. *The Wolf and the Street: narrative encounters with Mathematics*, in  
“Imagine Math 3” (Editor: Michele Emmer) pp. 225–234, Springer  
Verlag, 2015.
163. *Mathematics as culture and knowledge*, in “Les Dechiffreurs”, Belin  
2008.
164. *Noncommutative geometry and number theory*, in Nieuw Archief voor  
Wiskunde, (5) 9 (2008), no. 2, 109–112.
165. *Number theory in physics*, invited contribution to the “Encyclopaedia  
of Mathematical Physics” Elsevier.

## Older unpublished manuscripts

166. *Dynamical systems on spectral metric spaces* (with Jean Bellissard and Kamran Reihani), arXiv:1008.4617
167. *Anomalies, Dimensional Regularization, and Noncommutative Geometry* (with Alain Connes), unfinished, available at <http://www.its.caltech.edu/~matilde/anomalies.pdf>
168. *Exact triangles in Seiberg-Witten-Floer theory, Part II: geometric limits of flow lines*, (with Bai-Ling Wang)  
arXiv:math.DG/9907080 71 pages
169. *Exact triangles in Seiberg-Witten-Floer theory, Part III: the proof of exactness*, (with Bai-Ling Wang)  
arXiv:math.DG/0009157. 69 pages
170. *Exact triangles in Seiberg-Witten Floer theory. Part IV: Z-graded monopole homology*, (with Bai-Ling Wang)  
arXiv:math.DG/0009159. 34 pages
171. Система Обыкновенных Дифференциальных Уравнений Антисамодвойственных Связностей и Монополей Дирака,  
MPI preprints 2002-40. 7 pages

## Mathematical Activities

Regarding lectures and conferences: in the past ten years, 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 Morning-side 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

- 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  $F_1$ , 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”, Naples, 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 thématique: 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. Main organizer of the “Focus Program on New Geometric Methods in Neuroscience”, Fields Institute, Canada, February 24 – March 13, 2020
2. Conference “Geometrical and topological structures of information”, CIRM Luminy, France, August 2017.
3. Workshop “Algebraic and Geometric Deformation Spaces”, Bonn August 11-15, 2008 (co-organized with Hossein Abbaspour and Thomas Tradler).
4. Workshop “The manifold geometries of quantum field theory”, Bonn June 30-July 4, 2008 (co-organized with Sergio Albeverio and Hanno Gottschalk).
5. 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).
6. 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).
7. Workshop “Quantum Groups and Noncommutative Geometry”, MPIM Bonn, August 6-8, 2007 (co-organized with Deepak Parashar).
8. Workshop “Hochschild and Cyclic (co-)homology and Applications to Geometry and Physics” MPIM Bonn, July 16-19, 2007 (co-organized with Hossein Abbaspour).
9. Alain Connes 60th birthday conference IHES/IHP March 29-April 6, 2007 (co-organized with Henri Moscovici and Georges Skandalis)
10. Workshop “Combinatorics and Physics” MPIM Bonn, March 2007. (co-organized with Kurusch Ebrahimi-Fard and Walter van Suijlekom)
11. Workshop “Renormalization”, MPIM Bonn, December 15–16, 2006. (co-organized with Kurusch Ebrahimi-Fard)

12. “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).
13. “Traces in Geometry, Number Theory, and Quantum Fields”, MPIM September 28-October 7, 2005. (co-organized with Sergio Albeverio, Sylvie Paycha)
14. “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).
15. “Arithmetic Geometry and High Energy Physics”, Lorenz Center, Leiden, the Netherlands, August 29-September 2, 2005 (co-organized with Gunther Cornelissen and Andrew Waldron).
16. “Yuri Manin’s Emeritierung Conference”, MPIM Bonn February 24-26, 2005 (co-organized with Ivan Penkov and Don Zagier).
17. “Workshop on Noncommutative geometry and Number Theory, II”, MPI June 14-18, 2004 (co-organized with A.Connes, C.Consani, and Yu.Manin).
18. “Workshop on Noncommutative geometry and Number Theory”, MPI August 17-22, 2003 (co-organized with C.Consani and Yu.Manin).
19. “Frobenius manifolds, singularities, and quantum cohomology”, MPI July 8-19, 2002 (co-organized with B. Dubrovin, C. Hertling, Yu. Manin, K. Saito).
20. “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”
- Snigdhasyan 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”



### **Current PhD students:**

- Ismail Abouamal (University of Toronto)
- Sitanshu Gakkhar (University of Toronto)
- Elliott Gesteau (Perimeter Institute)
- Joshua Leiber (Caltech)
- Vasiliki Lontou (University of Toronto)
- Thomas Norton (Caltech)
- Jane Panangaden (Caltech)

### **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)
- The Geometry of Quantum States (Caltech 2012)
- Motives and Quantum Field Theory (Caltech 2014)
- 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)

- 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)
- 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)