

Arthur J. Parzygnat**Curriculum Vitae**

Experimental Study Group
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Academic positions held:	Massachusetts Institute of Technology, Cambridge, MA Lecturer in Mathematics (Experimental Study Group)	2023-present
	Nagoya University, Japan Designated Assistant Professor (Graduate School of Informatics) Supervisor: Francesco Buscemi	2022-2023
	Institut des Hautes Études Scientifiques (IHÉS), France Postdoc (Physics); Supervisor: Vasily Pestun	2019-2022
	University of Connecticut (UConn), Storrs, CT Assistant Research Professor (Mathematics); Supervisor: Ambar Sengupta	2016-2019
Education:	The CUNY Graduate Center (GC), New York, NY Ph.D., Physics; Thesis title: “ <i>Some 2-categorical Aspects in Physics</i> ” Advisors: V. Parameswaran Nair (Physics) and Scott O. Wilson (Math)	2010-2016
	Macaulay Honors College at Queens College of CUNY, Flushing, NY <i>Magna cum laude</i> , Physics (BS), Mathematics (BA), and Japanese (minor) Senior thesis title: “ <i>Homotopical field theories</i> ” Senior thesis advised under Scott O. Wilson, Queens College of CUNY	2006-2010
Grants, honors, and awards:	Blaumann Foundation research grant (co-investigator with James Fullwood)	2023
	Graduate Center Capelloni Dissertation Fellowship (Physics)	2015-2016
	National Science Foundation Graduate Research Fellowship (Math)	2011-2014
	Tomaszkiewicz-Florio Scholarship	2010/06
	Arthur Sard Memorial Award (Math)	2010/05
	Max Kupferberg Physics Scholarship (Physics)	2009/06
	Thomas Budne Memorial Award (Math)	2009/05
	Young Scientist Award	2009/04
	Member of Phi Beta Kappa	2009/01-Present
Summer Program for Undergraduate Research Fellowship	Summer 2008	
Teaching experience:	Multivariable Calculus (ES 18.02) at MIT	Fall 2023
	Honors Calculus I (Math 1151Q) at UConn	Fall 2018
	Analysis II (Math 3151) at UConn	Spring 2017
	Analysis I (Math 3150) at UConn	Fall 2016
	Applied Linear Algebra (Math 2210Q) at UConn	Fall 2016-Spring 2019
	Graduate student lecturer at the City College of New York	
	Alexios Polychronakos’ teaching assistant for Classical Mechanics	Spring 2015
Lab and recitation instructor for first year physics	Fall 2014-Spring 2016	
Instructional videos and material:	Over 30 hours of free educational video content on YouTube, including:	
	• Categorical probability theory (7 videos)	Fall 2020
	• Advanced topics in Linear Algebra (30 videos)	Spring 2019
	• Analysis II (68 videos, each \approx 12 minutes long)	Spring 2017
	Providing free written course material	
	• Calculus handouts (22 pages)	Fall 2018
• Linear Algebra notes (284 pages)	Fall 2018	
• Analysis II notes (204 pages)	Spring 2017	
• Analysis I notes (118 pages)	Fall 2016	

Mentorship, outreach, STEM accessibility:	Independent Study with undergraduate Aleksey Fylypiv at UConn “Stationary observers outside a black hole II” (Math 3799)	Spring 2019
	Spoke at the undergraduate UConn Math Club (slides) Title: “The contraction mapping theorem: Fractals from iterations”	2019/02/06
	Independent Study with undergraduate Aleksey Fylypiv at UConn “Stationary observers outside a black hole I” (Math 3799)	Fall 2018
	Spoke at the undergraduate UConn Math Club (notes and handout) Title: “The Physics and Mathematics of Special Relativity”	2018/02/21
	Mentored two high school students in the Nano-structured Photonics and Materials Laboratory under Sajan Saini at Queens College of CUNY Tutored children, teenagers, and adults in mathematics and physics	2008-2009 2004-2016
Scholarly service:	Reviewer/referee for <i>IEEE Transactions on Information Theory, Quantum Information Processing 2023, Journal of Machine Learning Research, Quantum, Journal of Stochastic Analysis</i>	
	Panel member for professional development at the 1st Interdisciplinary Science Student Conference at the GC	Apr 2012
Conferences organized:	“ Horizons of Quantum Information Workshop ” February 6-7, 2023 at Nagoya University in Nagoya, Japan (co-organized with James Fullwood and Francesco Buscemi)	2023/02
Publications:	16. (with Luca Giorgetti, Alessio Ranallo, and Benjamin P. Russo) “Bayesian inversion and the Tomita–Takesaki modular group” <i>Quart. J. Math.</i> 74 , 3, 975–1014 (2023). DOI: 10.1093/qmath/haad014 , arXiv: 2112.03129 [math.OA]	2023/09
	15. (with Benjamin P. Russo) “Non-commutative disintegration: existence and uniqueness in finite dimensions” <i>J. Noncommut. Geom.</i> 17 (2023), no. 3, pp. 899–955. DOI: 10.4171/jncg/493 , arXiv: 1907.09689 [quant-ph]	2023/07
	14. (with James Fullwood) “From time-reversal symmetry to quantum Bayes’ rules” <i>PRX Quantum</i> 4 , 020334 (2023). DOI: 10.1103/PRXQuantum.4.020334 , arXiv: 2212.08088 [quant-ph]	2023/06
	13. (with Francesco Buscemi) “Axioms for retrodiction: achieving time-reversal symmetry with a prior” <i>Quantum</i> 7 , 1013 (2023). DOI: 10.22331/q-2023-05-23-1013 , arXiv: 2210.13531 [quant-ph]	2023/05
	12. (with James Fullwood) “On quantum states over time” <i>Proc. R. Soc. A.</i> 478 : 20220104. DOI: 10.1098/rspa.2022.0104 , arXiv: 2202.03607 [quant-ph]	2022/08
	11. (with Benjamin P. Russo) “A non-commutative Bayes’ theorem” <i>Linear Algebra Appl.</i> 644 (2022), pp 28–94. DOI: 10.1016/j.laa.2022.02.030 , arXiv: 2005.03886 [quant-ph]	2022/07
	10. (with Byungdo Park, Corbett Redden, and Augusto Stoffel) “Noncommutative differential K-theory” <i>J. Geom. Phys.</i> 174 (2022), 104446. DOI: 10.1016/j.geomphys.2021.104446 , arXiv: 2106.12073 [math.KT]	2022/04
	9. “A functorial characterization of von Neumann entropy” <i>Cah. Topol. Géom. Différ. Catég.</i> LXIII , 1 (2022), 89–128, arXiv: 2009.07125 [quant-ph]	2022/01
	8. (with James Fullwood) “The information loss of a stochastic map,” <i>Entropy</i> 23 , no. 8 (2021). DOI: 10.3390/e23081021 , arXiv: 2107.01975 [cs.IT]	2021/08
	7. “Towards a functorial description of quantum relative entropy,” in: Nielsen F., Barbaresco F. (eds) <i>Geometric Science of Information. GSI 2021. Lecture Notes in Computer Science</i> , vol 12829 . Springer, Cham. (2021). DOI: 10.1007/978-3-030-80209-7_60 , arXiv: 2105.04059 [quant-ph]	2021/07
6. “Conditional distributions for quantum systems,” EPTCS 343, <i>Proceedings 18th International Conference on Quantum Physics and Logic</i> (2021), pp 1–13. DOI: 10.4204/EPTCS.343.1 , arXiv: 2102.01529 [quant-ph]	2021/02	
5. “Stinespring’s construction as an adjunction,” <i>Compositionality</i> 1 , 2 (2019).		

	DOI: 10.32408/compositionality-1-2 , arXiv: 1807.02533 [math.OA]	2019/12
	4. “Two-dimensional algebra in lattice gauge theory,” <i>J. Math. Phys.</i> 60 043506 (2019). DOI: 10.1063/1.5078532 , arXiv: 1802.01139 [hep-th]	2019/04
	3. “From Observables and States to Hilbert Space and Back: A 2-Categorical Adjunction,” <i>Appl. Categorical Struct.</i> 26 , Issue 6 (2018), pp 1123–1157. DOI: 10.1007/s10485-018-9522-6 , arXiv: 1609.08975 [math-ph]	2018/03
	2. “Gauge invariant surface holonomy and monopoles,” <i>Theory Appl. Categories</i> 30 , 2015, No. 42, pp 1319-1428, arXiv: 1410.6938 [math-ph]	2015/10
	1. (with Karen K. Y. Lee, Yehuda Avniel, and Steven G. Johnson) “Sufficient conditions for two-dimensional localization by arbitrarily weak defects in defects in periodic potentials with band gaps,” <i>Phys. Rev. B</i> 81 , 155324 (2010). DOI: 10.1103/PhysRevB.81.155324 , arXiv: 1002.4426 [cond-mat.other]	2010/04
Preprints in submission:	4. (with James Fullwood, Francesco Buscemi, Giulio Chiribella) “Virtual quantum broadcasting,” (14 pages), arXiv: 2310.13049 [quant-ph]	2023/10
	3. (with Tadashi Takayanagi, Yusuke Taki, Zixia Wei) “SVD entanglement entropy” (49 pages), arXiv: 2307.06531 [hep-th]	2023/07
	2. (with James Fullwood) “On dynamical measures of quantum information” (53 pages), arXiv: 2306.01831 [quant-ph]	2023/06
	1. “Inverses, disintegrations, and Bayesian inversion in quantum Markov categories” (91 pages), arXiv: 2001.08375 [quant-ph]	2020/01
Book material:	“Discrete probabilistic and algebraic dynamics: a stochastic commutative Gelfand–Naimark Theorem” (71 pages), arXiv: 1708.00091 [math.FA]	2017/07
Works in progress:	6. (w. Francesco Buscemi, James Fullwood) “What can replace joint probabilities in quantum theory?” (working title)	
	5. “Retrodiction for semicartesian monoidal categories”	
	4. “Retrodiction versus error-correction”	
	3. “Strengthening the data-processing inequality with Bayesian inverses”	
	2. (w. Vasily Pestun) “Optimal experiment design for quantum state determination”	
	1. “Jeffrey conditioning and Bayesian inference in quantum mechanics”	
Research experience and academic activities:	Visiting Tadashi Takayanagi at the Yukawa Institute for Theoretical Physics (YITP) at Kyoto University in Kyoto, Japan	2023 March 13–24
	Visiting Joonwoo Bae at the Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, South Korea	2023 Feb 20–24
	Visiting Tadashi Takayanagi at the Yukawa Institute for Theoretical Physics at Kyoto University in Kyoto, Japan	2022 December 12–23
	Selected participant of “QMATH Masterclass 2022: Entropy Inequalities in Quantum Information Science” at Copenhagen University in Copenhagen, Denmark [Unable to attend QMATH’22 due to Covid]	2022 August 22-26
	Member of “Quantum information for theoretical physics” under the Extreme Universe Collaboration Principal investigator: Tomoyuki Morimae Head investigator: Tadashi Takayanagi	May 2022-June 2023
	Selected participant of <i>Prospects in Theoretical Physics 2015 - Princeton Summer School on Condensed Matter Physics</i> “New Insights Into Quantum Matter” at Princeton University in Princeton, New Jersey	2015 July 20-31
	Member of “CUNY biophysics discussion group” at the City College of New York (leader: Joseph Brisendine)	2014-2015
	Member of “Topological K-theory and Algebraic Topology Group” at the CUNY Graduate Center (leader: Mahmoud Zeinalian)	Fall 2013-Spring 2016

Research intern under Steven G. Johnson, MIT Summer 2009
 Theoretical condensed matter
 Research assistant in the Nano-structured Photonics and 2008-2009
 Materials Laboratory under Sajan Saini, Queens College of CUNY
 Theoretical, numerical, and experimental solid state

**Conference
and seminar
talks:**

Topology, Geometry, and Physics Seminar at The CUNY Graduate Center (online)
 Title: “Axioms of Bayesian inference, retrodiction, and post-diction in
 classical and quantum probability”
 Host: Mahmoud Zeinalian 2023/10/25
 CQT Seminar at The Centre for Quantum Technologies in Singapore (online)
 Title: “Fully quantum Bayes’ rule from states over time”
 Hosts: Mankei Tsang and Valerio Scarani 2023/08/07
 The New York City Category Theory Seminar at the CUNY Graduate Center
 Title: “Inferring the past and using category theory to define retrodiction” (video)
 Host: Noson Yanofsky 2023/05/17
 International Workshop on Foundation of Quantum Physics and Its Mathematics
 at Suwa University of Science, Chino, Nagano, Japan
 Title: “Defining states over time from an initial state and evolution”
 Hosts: Takashi Matsuoka and Luigi Accardi 2023/03/02
 KAIST-Nagoya GENKO Workshop: Entanglement and Quantum Markovian Process
 at Korea Advanced Institute of Science & Technology (KAIST), Daejeon, Korea
 Title: “Approaching quantum Bayesian inference from two new angles”
 Host: Joonwoo Bae 2023/02/23
 The 1st Workshop of Extreme Universe for Young Researchers
 at Nagoya University in Nagoya, Japan
 Title: “From time-reversal symmetry to quantum Bayes’ rules” 2023/02/13
 The Second Annual Meeting of the Extreme Universe Collaboration
 at the Kobe Convention Center in Kobe, Japan
 Title: “Axioms for Quantum Retrodiction” 2022/12/28
 Quantum Information seminar
 at the Yukawa Institute of Theoretical Physics, Kyoto University in Kyoto, Japan
 Title: “Retrodiction: time-reversal symmetry for quantum channels”
 Host: Tomoyuki Morimae and Yoshifumi Nakata 2022/12/19
 The 9th Extreme Universe (ExU) circular meeting (held online)
 Title: “A tutorial on time symmetry and quantum Bayes’ rules” 2022/10/28
 ExU International Workshop “Quantum extreme universe from quantum information”
 at the Yukawa Institute of Theoretical Physics, Kyoto University in Kyoto, Japan
 Title: “Quantum states over time” (video)
 Hosts: Tadashi Takayanagi and organizers 2022/09/26
 Categorical Semantics of Entropy at the CUNY Graduate Center in New York
 Title: “On characterizing classical and quantum entropy” (video)
 Host: John Terilla 2022/05/13
 Huawei’s Lagrange Center in Paris, France
 Title: “Categorical approach to Bayesian inference and its realization
 for quantum systems”
 Host: Laurent Lafforgue 2022/04/26
 Mathematics Seminar at the Simons Center for Geometry and Physics
 in Stony Brook, New York
 Title: “Bayes’ theorem via categories”
 Hosts: Catherine Cannizzo and Olivier Martin 2022/03/10
 42nd International Conference on Quantum Probability and Infinite Dimensional
 Analysis (QP-42) at the Indian Statistical Institute in Bangalore, India (online)
 Title: “Conditional Expectations And Bayes’ Theorem”

Hosts: Rajarama Bhat and organizers 2022/01/17
 Cohomology in algebra, geometry, physics and statistics seminar at The Institute
 of Mathematics of the Czech Academy of Sciences in Prague, Czechia (online)
 Title: “A categorical approach to quantum probability” ([video](#))
 Host: Hông Văn Lê 2021/11/03
 5th Conference on Geometric Science of Information (GSI’21)
 at Sorbonne University in Paris, France
 Title: “Towards a functorial description of quantum relative entropy” ([video](#))
 Hosts: Frédéric Barbaresco and Frank Nielsen 2021/07/23
 Oxford ZX-Calculus Seminar in Oxford, England (online)
 Title: “Quantum Bayesian inversion and conditional distributions” ([video](#))
 Hosts: Cole Comfort and Bob Coecke 2021/07/19
 18th International Conference on Quantum Physics and Logic (held online)
 Title: “Conditional distributions for quantum systems” ([video](#)) 2021/06/07
 Seminario de Categorías de la UNAM in Mexico City, Mexico (online)
 Title: “String diagrams for C^* -algebras and Bayesian inversion” ([video](#))
 Host: Juan Orendain 2021/03/03
 The New York City Category Theory Seminar at the CUNY Graduate Center (online)
 Title: “A functorial characterization of classical and quantum entropies” ([video](#))
 Host: Noson Yanofsky 2020/12/16
 MIT (Applied) Categories Seminar (online)
 Title: “Stinespring’s construction as an adjunction” ([video](#))
 Hosts: Brendan Fong and David Spivak 2020/12/03
 Categorical Probability and Statistics workshop 2020 (held online)
 Title: “Categorical probability in the quantum realm” ([video](#))
 Organizers: Tobias Fritz and Rory B. B. Lucyshyn-Wright 2020/06/08
 Category Theory 2019 at the University of Edinburgh
 Title: “Non-commutative disintegrations and
 regular conditional probabilities” ([slides](#)) 2019/07/09
 Operator Algebras and Applications at the Simons Center for Geometry
 and Physics in Stony Brook, New York
 Title: “Non-commutative disintegrations” ([video](#)) 2019/06/17
 Joint Mathematics Meeting (JMM) 2019 in Baltimore, Maryland
 Title: “Non-commutative disintegration” ([slides](#)) 2019/01/19
 The Topology Seminar at the Korean Institute of Advanced Study
 (KIAS) in Seoul, Korea
 Talk 1 title: “Probability monads”
 Talk 2 title: “Using category theory for non-commutative probability”
 Host: Byungdo Park 2018/11/21
 Third Northeastern Analysis Meeting (NEAM) at SUNY New Paltz
 Title: “Non-commutative disintegration” ([slides](#)) 2018/10/20
 The S.I.G.M.A. Seminar at UConn
 Title: “Cupcakes versus muffins: support vector machines” ([slides](#))
 Host: Lisa Naples 2018/01/26
 Second Northeastern Analysis Meeting (NEAM) at University at Albany (SUNY)
 Title: “Categories in Probability” ([slides](#)) 2017/11/14
 The Analysis Learning Seminar at UConn
 Title: “Algebraic Probability and Stochastic Processes I, II, and III”
 Subtitle: “A stochastic Gelfand-Naimark Theorem” 2017/04/14
 Subtitle: “The Gelfand-Naimark Theorem” 2017/03/31
 Subtitle: “Finite probability theory and positive maps” 2017/03/24
 Mathematical Physics, Fourier Analysis, and Applications Seminar
 at the CUNY Graduate Center
 Title: “Completely positive maps in quantum mechanics and probability theory”

	Host: Azita Mayeli	2017/03/17
	The S.I.G.M.A. Seminar at UConn	
	Title: “Convex categories and entropy” (notes)	
	Host: Phaniel Mariano	2016/12/02
	Representation Theory Seminar at the GC	
	Title: “From observables and states to Hilbert space and back”	
	Host: Azita Mayeli	2016/10/07
	CCNY Student Research Symposium at the City College of New York	
	Title: “Two-dimensional algebra and gauge theory” (slides)	2016/05/10
	High Energy Physics Seminar at the City College of New York	
	Title: “Two-dimensional algebra and gauge theory for strings” (slides)	
	Host: Sebastian Franco	2016/03/18
	AMS Spring Eastern Sectional Meeting at Georgetown University, Washington, DC	
	Title: “Two-dimensional iterated integrals and applications in classical gauge theory” (slides)	2015/03/08
	11th Annual Graduate Student Topology & Geometry Conference at the University of Notre Dame	
	Title: “2-bundles over 2-spaces”	2013/04/06
	Boosting the Power of SUNY and CUNY: A Celebration of Graduate Research in Albany, New York	
	Poster title: “Configuration Spaces”	2013/02/26
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Seminars	Mathematical Physics Seminar at UConn	Spring 2018–Fall 2019
Organized:	CCNY Physics Journal Club	Fall 2014–Spring 2016
	Algebraic Topology Student Seminar (w. other students)	Fall 2014–Spring 2015
	Mathematical Physics, Fourier Series, and Applications (w. Azita Mayeli)	Fall 2014
	Mathematical Physics and Harmonic Analysis (w. Azita Mayeli)	Spring 2014
	Mathematical Physics Seminar	Spring 2013–Fall 2013
	Foundations of Physics	Spring 2012–Fall 2014
	(w. Ryan Abrahams and Marcelo Nomura)	
	Gauge Theory Seminar (w. Brian Sulkow)	Fall 2011–Fall 2012
	Categories and Linear Algebra (unofficial course taught by me)	Fall 2011
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Skills:	L ^A T _E X including plots, graphs, for-loops, graphics, etc. in TikZ & xy Mathematica, Excel, Photoshop, Gimp, video editing	
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Languages:	English (native), Polish (native), Japanese (intermediate), French (beginner)	

References:

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