

Arthur J. Parzygnat

Curriculum Vitae

Graduate School of Informatics
Nagoya University
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<https://arthurparzygnat.com/>
<https://www.youtube.com/c/ArthurParzygnat>

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| Academic positions held: | Nagoya University, Japan Specially Appointed Assistant Professor in Mathematical Informatics Supervisor: Francesco Buscemi | 2022-present |
| | Institut des Hautes Études Scientifiques (IHÉS), France Postdoc in Physics Supervisor: Vasily Pestun | 2019-2022 |
| | University of Connecticut (UConn), Storrs, CT Assistant Research Professor in Mathematics Supervisor: Ambar Sengupta | 2016-2019 |

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| Education: | The CUNY Graduate Center (GC), New York, NY Ph.D., Physics Advisors: V. Parameswaran Nair (Physics) and Scott O. Wilson (Math) Thesis title: “ <i>Some 2-categorical Aspects in Physics</i> ” | 2010-2016 |
| | Macaulay Honors College at Queens College, Flushing, NY <i>Magna cum laude</i> , Physics (BS), Mathematics (BA), and Japanese (minor) Senior thesis advised under Scott O. Wilson, Queens College Senior thesis title: “ <i>Homotopical field theories</i> ” | 2006-2010 |

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| Grants, honors, and awards: | 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 | |

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| Teaching experience: | 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 the CUNY Teacher’s assistant for Classical Mechanics Lab and recitation instructor for first year physics | Spring 2015 Fall 2014-Spring 2016 |

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| 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 (28 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 | |

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| Mentorship and scholarly service: | Referee for the <i>Journal of Machine Learning Research</i> | 2022 |
| | Referee for the journal <i>Quantum</i> | 2022 |
| | Referee for the <i>Journal of Stochastic Analysis</i> | 2021 |
| | “Stationary observers outside a black hole II” (Math 3799) at UConn Independent Study with undergraduate Aleksey Fylypiv | Spring 2019 |
| | “Stationary observers outside a black hole I” (Math 3799) at UConn Independent Study with undergraduate Aleksey Fylypiv | Fall 2018 |
| | Panel member for professional development at the 1st Interdisciplinary Science Student Conference at the GC | Apr 2012 |
| Publications: | <ol style="list-style-type: none"> 13. (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 12. (with Benjamin P. Russo) “Non-commutative disintegration: existence and uniqueness in finite dimensions” (51 pages) Accepted in <i>Journal of Noncommutative Geometry</i>, arXiv: 1907.09689 [quant-ph] 2022/— 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 | |
| Submitted: | <ol style="list-style-type: none"> 2. (with Luca Giorgetti, Alessio Ranallo, and Benjamin P. Russo) “Bayesian inversion and the Tomita–Takesaki modular group” (38 pages) arXiv: 2112.03129 [math.OA] 2021/12 1. “Inverses, disintegrations, and Bayesian inversion in quantum Markov categories” (91 pages) arXiv: 2001.08375 [quant-ph] 2020/01 | |

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| Book material: | “Discrete probabilistic and algebraic dynamics: a stochastic commutative Gelfand–Naimark Theorem” (71 pages) arXiv: 1708.00091 [math.FA] | 2017/07 |
| Papers in progress: | <ol style="list-style-type: none"> 5. “Strengthening the data-processing inequality with Bayesian inverses” 4. (with Francesco Buscemi) “Axiomatic foundations for retrodiction” (31 pages) 3. (with James Fullwood) “Quantum Bayes’ rules from states over time” (10 pages) 2. (with Vasily Pestun) “Optimal experiment design for quantum state determination” 1. “Jeffrey conditioning and Bayesian inference in quantum mechanics” (15 pages) | |
| Research experience and activities: | <p>Selected participant of “QMATH Masterclass 2022: Entropy Inequalities in Quantum Information Science” at Copenhagen University in Copenhagen, Denmark</p> <p>Member of “Quantum information for theoretical physics” under the Extreme Universe Collaboration Principal investigator: Tomoyuki Morimae Head investigator: Tadashi Takayanagi</p> <p>Member of “Topological K-theory and Algebraic Topology Group” at the CUNY Graduate Center (leader: Mahmoud Zeinalian)</p> <p>Research intern under Steven G. Johnson, MIT Theoretical condensed matter</p> <p>Research assistant in the Nano-structured Photonics and Materials Laboratory under Sajjan Saini, Queens College Theoretical, numerical, and experimental solid state</p> | <p>2022 August 22-26</p> <p>Spring 2022-present</p> <p>Fall 2013- -Spring 2016</p> <p>Summer 2009</p> <p>2008-2009</p> |
| Conference and seminar talks: | <p>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 Host: Tadashi Takayanagi and organizers</p> <p>Categorical Semantics of Entropy at the CUNY Graduate Center in New York Title: “On characterizing classical and quantum entropy” (video) Host: John Terilla</p> <p>Huawei’s Lagrange Center in Paris, France Title: “Categorical approach to Bayesian inference and its realization for quantum systems” Host: Laurent Lafforgue</p> <p>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</p> <p>42nd International Conference on Quantum Probability and Infinite Dimensional Analysis (QP-42) at the Indian Statistical Institute in Bangalore, India Title: “Conditional Expectations And Bayes’ Theorem” Hosts: Rajarama Bhat and organizers</p> <p>Cohomology in algebra, geometry, physics and statistics seminar at The Institute of Mathematics of the Czech Academy of Sciences in Prague, Czechia Title: “A categorical approach to quantum probability” (video) Host: Hông Vân Lê</p> <p>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</p> <p>Oxford ZX-Calculus Seminar in Oxford, England Title: “Quantum Bayesian inversion and conditional distributions” (video) Hosts: Cole Comfort and Bob Coecke</p> <p>18th International Conference on Quantum Physics and Logic</p> | <p>2022/09/26</p> <p>2022/05/13</p> <p>2022/04/26</p> <p>2022/03/10</p> <p>2022/01/17</p> <p>2021/11/03</p> <p>2021/07/23</p> <p>2021/07/19</p> |

Title: “Conditional distributions for quantum systems” ([video](#)) 2021/06/07
 Seminario de Categorías de la UNAM in Mexico City, Mexico

Title: “String diagrams for C^* -algebras and Bayesian inversion” ([video](#))
 Host: Juan Orendain 2021/03/03
 The New York City Category Theory Seminar

Title: “A functorial characterization of classical and quantum entropies” ([video](#))
 Host: Noson Yanofsky 2020/12/16
 MIT (Applied) Categories Seminar

Title: “Stinespring’s construction as an adjunction” ([video](#))
 Hosts: Brendan Fong and David Spivak 2020/12/03
 Categorical Probability and Statistics workshop 2020

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
 UConn Math Club

Title: “The contraction mapping theorem: Fractals from iterations” ([slides](#)) 2019/02/06
 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 Mathematical Physics Seminar at UConn

Title: “Direct integrals” 2018/10/03
 UConn Math Club

Title: “The Physics and Mathematics of Special Relativity” ([notes and handout](#)) 2018/02/21
 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: Phanael Mariano 2016/12/02
 Representation Theory Seminar at the GC

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| | Title: “From observables and states to Hilbert space and back” | 2016/10/07 |
| | Host: Azita Mayeli | |
| | CCNY Student Research Symposium at the City College of New York of CUNY | |
| | Title: “Two-dimensional algebra and gauge theory” (slides) | 2016/05/10 |
| | High Energy Physics Seminar at the City College of New York of CUNY | |
| | 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 presentation title: “Configuration Spaces” | 2013/02/26 |
| Seminars Organized: | Mathematical Physics Seminar at UConn | Spring 2018–Fall 2019 |
| | 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 |
| Skills: | L ^A T _E X including plots, graphs, for-loops, graphics, etc. in TikZ & xy Mathematica Photoshop, Gimp, video editing | |
| Languages: | English (native), Polish (native), Japanese (intermediate), French (beginner) | |
| References: | Scott O. Wilson Professor of Mathematics Queens College 609 Kiely Hall 65-30 Kissena Blvd Queens, NY 11367 USA scott.wilson@qc.cuny.edu | V. Parameswaran Nair Distinguished Professor of Physics City College of the CUNY 160 Convent Avenue New York, NY 10031 (212) 650-5572 vpnair@ccny.cuny.edu |
| | Ambar Sengupta Professor of Mathematics University of Connecticut 341 Mansfield Road Unit 1009 Storrs, CT 06269-1009 (860) 486-1290 ambar.sengupta@uconn.edu | Francesco Buscemi Professor of Informatics Graduate School of Informatics Nagoya University Chikusa-ku, 464-8601 Nagoya, Japan buscemi@nagoya-u.jp |
| | Keith Conrad Associate Professor of Mathematics University of Connecticut 341 Mansfield Road Unit 1009 Storrs, CT 06269-1009 (860) 486-3923 kconrad@math.uconn.edu | |