Iván Mauricio **Burbano Aldana**

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Education

University of California, Berkeley
Berkeley, USA

PH.D. IN PHYSICS — *January 2021 – July 2026 (expected)*

- GPA: 4.0/4.0.
- Supervised by Dr. Raúl A. Briceño and Dr. Christian W. Bauer.

Perimeter Institute for Theoretical Physics, University of Waterloo
Waterloo, Canada

M.SC. IN THEORETICAL PHYSICS — *August 2019 – December 2020*

- Perimeter Scholars International Program completed on June 2020.

Instituto de Física Teórica, Universidade Estadual Paulista "Júlio de Mesquita Filho"
São Paulo, Brazil

MASTER'S IN THEORETICAL PHYSICS — *February 2019 – August 2020*

- Thesis: Cohomological Field Theory in the BV Formalism, supervised by Dr. Kevin Costello and Dr. Kasia Rejzner.
- Grade: A (maximum grade).

Universidad de los Andes
Bogotá D.C., Colombia

MASTER'S IN PHYSICS (NOT COMPLETED) — *January 2018 – December 2018*

- Grade: 4.64/5.00.
- Interrupted to pursue the SAIFR-Perimeter Fellowship.

Universidad de los Andes
Bogotá D.C., Colombia

UNDERGRADUATE DEGREE IN PHYSICS — *July 2014 – March 2018*

- Thesis: KMS States and Tomita-Takesaki Theory, supervised by: Dr. Andrés Fernando Reyes Lega.
- Graduated with Cum Laude honors.
- Minor: Mathematics.
- Grade: 4.72/5.00.

Research Experience

University of California, Berkeley and Lawrence Berkeley National Lab
Berkeley, USA

GRADUATE STUDENT RESEARCHER — *June 2023 – Present*

- Proposed two new formulations of Yang-Mills theory aimed at implementations on quantum computers.
- Benchmarked a large N formulation through tensor networks.
- Currently preparing an experiment on quantum hardware through this formulation.
- Currently implementing formalism to study reactions mediated by electroweak currents through lattice QCD.
- Finishing consistency checks on the $\mathrm{O}(3)$ nonlinear sigma model for these kind of reactions.
- Clarified the internal structure associated to the normalization of the path integral, leading to new insights into the chiral anomaly.

Perimeter Institute for Theoretical Physics
Waterloo, Canada

MASTER'S THESIS — *August 2019 – June 2020*

- Did a classification of all non-invertible Kramers-Wannier duality defects in the chiral $(E_8)_1$ WZW model coming from $\mathbb{Z}_m$ symmetries.
- Provided a defect interpretation for Unruh-DeWitt particle detectors.

Universidad de los Andes
Bogotá D.C., Colombia

RESEARCH MASTER'S GRADUATE ASSISTANT — *June 2018 – July 2018*

- Identified and proved the existence of an emerging gauge group in purification schemes through the Gelfand-Naimark-Segal representation.

California Institute of Technology
Pasadena, USA

SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP — *June 2017 – August 2017*

- Aided the investigation, characterization, and correction of image centroid motions at the Precision Projector Laboratory in the Jet Propulsion Laboratory (NASA).
- Built Distortionator, a Python program that aids the analysis of distortions in a two dimensional lattice by calculating the convergence, shears, rotations, and translations between different instances of the lattice.
- The detectors investigated will be used for the study of weak gravitational lenses and dark matter in missions such as WFIRST and Euclid.
- Supervised by Dr. Roger Smith and Dr. Andrés Alejandro Plazas Malagón.

Publications

- I. M. Burbano, M. A. Carrillo, R. Urek, A. N. Ciavarella and R. A. Briceño, "Real-time Estimators for Scattering Observables: A full account of finite volume errors for quantum simulation," [arXiv:2506.06511 [hep-lat]].
- A. N. Ciavarella, I. M. Burbano and C. W. Bauer, "Efficient Truncations of SU(N_c) Lattice Gauge Theory for Quantum Simulation," [arXiv:2503.11888 [hep-lat]].
- I. M. Burbano and C. W. Bauer, "Gauge Loop-String-Hadron Formulation on General Graphs and Applications to Fully Gauge Fixed Hamiltonian Lattice Gauge Theory," [arXiv:2409.13812 [hep-lat]].
- I. M. Burbano and F. Calderón, "Self-Normalizing Path Integrals," Found. Phys. **54**, no.5, 60 (2024) [arXiv:2109.00517 [hep-th]].
- I. M. Burbano, J. Kulp and J. Neuser, "Duality defects in E_8," JHEP **10**, 186 (2022) [arXiv:2112.14323 [hep-th]].
- I. M. Burbano, T. R. Perche and B. de S.L. Torres, "A path integral formulation for particle detectors: the Unruh-DeWitt model as a line defect," JHEP **03**, 076 (2021) [arXiv:2012.14912 [hep-th]].
- A. P. Balachandran, I. M. Burbano, A. F. Reyes-Lega and S. Tabban, "Emergent Gauge Symmetries and Quantum Operations," J. Phys. A **53**, no.6, 06LT01 (2020) [arXiv:1906.05464 [quant-ph]].

Honors, Awards & Grants

2025	**Winning Team of Student Challenge**, Niels Bohr Quantum Summer School	*Denmark*
2024	**HUGS Third Place Seminar Price**, Jefferson Lab	*USA*
2022	**Outstanding Graduate Student Instructor Award**, UC Berkeley	*USA*
2018	**SAIFR-Perimeter Fellowship**, Journeys into Theoretical Physics: The fellowship included $\sim$ USD $34,000$ for my studies in Canada (including tuition) and $\sim$ USD $6,000$ for my studies in Brazil (not including tuition). Out of the 688 applicants, I was one of the 26 accepted to the Perimeter Scholars International program.	*Brazil*
2018	**Quantum Entropy Ambiguities and Modular Theory**, INV-2018-34-1295, Universidad de los Andes: Received a grant for $\sim$ USD $1,300$ destined towards publishing "Emergent Gauge Symmetries and Quantum Operations" and presenting it in an international scientific event.	*Colombia*
2018	**Cum Laude Undergraduate Degree**, Universidad de los Andes: Graduated with a global GPA in the top 3% over the past 5 years in the faculty of sciences.	*Colombia*
2015/2017	**Semiannual Excellence**, Universidad de los Andes: Obtained the highest GPA of the semester in the physics department.	*Colombia*
2016	**Ramón de Zubiría**, Universidad de los Andes: Obtained the highest overall GPA in the physics department.	*Colombia*
2014	**Honorable Mention**, 45th International Physics Olympiad	*Kazakhstan*
2013	**Third Place**, XXIX Olimpiada Colombiana de Física	*Colombia*

Teaching Experience

University of California, Berkeley

Berkeley, USA

Graduate Student Instructor

January 2021 – May 2023

- – Quantum Mechanics II (gradschool), discussion, Spring 2023
  – Introduction to Statistical and Thermal Physics, discussion, Fall 2022
  – Analytic Mechanics, discussion, Summer 2022
  – Introduction to Mathematical Physics, discussion, Spring 2022.
  – Introductory Mechanics and Relativity, discussion, Fall 2021.
  – Physics for Scientists and Engineers, discussion and lab, Spring 2021 (2 sections).
- Led discussion sections and designed/graded quizzes, homework and work sheets.

University of California, Berkeley

Berkeley, USA

Service work

January 2021 – Present

- Did 4 semesters of mentoring for the N3AS Undergraduate Research Program
- Mentored 7 Physics Directed Reading Programs
- Taught in Python4STEM and codirected the Monte Carlo for Statistical Field Theories programs in REYES. Was part of the teaching team for two in-person editions of Python4Physics for historically underserved communities in the Bay Area.

Perimeter Institute for Theoretical Physics

Waterloo, Canada

Teaching Assistant

May 2020 – June 2020

- Aided the Symmetries course of the Undergraduate Theoretical Physics Summer Program

Universidad de los Andes *Bogotá D.C., Colombia*

Teaching Master's Graduate Assistant *January 2018 – December 2018*

- – Physics 2, discussion, Fall 2018.
  – Experimental Physics 1, Fall 2018 (2 sections).
  – Physics 1, discussion Spring 2018.
  – Basic Physics 1, discussion Spring 2018 (2 sections).
- Led discussion sections and designed/graded quizzes, homework and work sheets.
- Conducted experiments using Logger Pro and other Vernier educational devices.

Universidad de los Andes *Bogotá D.C., Colombia*

Teaching Assistant *January 2016 – December 2016*

- – Linear Algebra 2 with Dr. Cesar Neyit Galindo Martinez in Fall 2016.
  – Linear Algebra (Honors) with Dr. Sergio Miguel Adarve Delgado in Spring 2016.
- Graded homework and held office hours to help students with their questions.
- Clinic for Problem-Solving in Fall 2016: helped students of first and second-year physics courses with their homeworks and related inquiries.

Presentations

2025	**Real-time Estimators for Quantum Observables**, Multi-Particle Reactions, UC Berkeley	*USA*
2024	**Towards $\gamma^*\gamma^* \to \pi\pi$ on the Lattice**, HUGS Seminar, Jefferson Lab	*USA*
2024	**Loop-String-Hadron on a Maximal Tree: A tale of gauge invariance and flowers**, Theory Seminar, Jefferson Lab	*USA*
2023	**Matemática-Física: Nudos, Geometría y Supersimetría**, ICTP Physics Without Frontiers	*Online*
2022	**Teorema de Noether: Aspectos variacionales, simplécticos y cohomológicos**, Differential Geometry and Mathematical Physics	*Online*
2021	**Path Integrals: summing over a whole new infinity**, The Compass Lectures, UC Berkeley	*USA*
2021	**Integrales de Camino: sumando sobre toda una nueva infinidad**, Seminario Estudiantil Iberoamericano de Física Teórica	*Online*
2020	**Introducción al Formalismo BV**, Seminario Estudiantil Iberoamericano de Física Teórica	*Online*
2019	**Emerging Gauge Symmetries and Quantum Operations**, Emmy Noether Workshop: The Structure of Quantum Spacetime, Perimeter	*Canada*
2019	**Emerging Gauge Symmetries and Quantum Operations**, 4th Joint Dutch-Brazil School on Theoretical Physics, IFT	*Brazil*
2018	**The Definition of a von Neumann Algebra**, Quantum Field Theory and Mathematical Physics Seminar, Uniandes	*Colombia*
2018	**Applitcations of Tomita-Takesaki Theory to Quantum Physics I**, Noncommutative Geometry and Poisson Geometry Around Groupoids	*Colombia*
2018	**Quantum Logic and the Orthocomplemented Lattice of Propositions**, Quantum Optics Seminar, Uniandes	*Colombia*
2018	**KMS States and Tomita-Takesaki Theory**, Topological Order and Beyond, Uniandes	*Colombia*
2018	**Algebraic Formulation of Quantum Physics**, Quantum Field Theory and Mathematical Physics Seminar, Uniandes	*Colombia*
2017	**On the Communication and Censorship of Science**, La Cicuta Magazine 7th Edition Release, Uniandes	*Colombia*
2017	**Orthocomplemented Quantum Lattices of Propositions**, Quantum Field Theory and Mathematical Physics Seminar, Uniandes	*Colombia*

Schools and Conferences Attended

2025	**Niels Bohr Quantum Summer School**, University of Copenhagen - Niels Bohr Institute	*Denmark*
2025	**Multi-Particle Reactions Summer School - Workshop**, UC Berkeley	*USA*
2024	**Unraveling the Particle World and the Cosmos at Berkeley**, UC Berkeley	*USA*
2024	**Hampton University Graduate Studies Program**, Jefferson Lab	*USA*
2023	**U.S. Quantum Information Science Summer School**, Fermilab	*USA*
2022	**Field Theories and Vertex Algebras**, University of California, Los Angeles	*USA*
2022	**Physical Mathematics of Quantum Field Theory**, University of Massachusetts, Amherst	*USA*
2021	**Blackwell Tapia Conference 2021**, Mathematical Sciences Research Institute	*USA*
2021	**Chern-Simons and Other Topological Field Theories**, Mathematical Sciences Research Institute	*USA*

2019	**Minicourse on Quantum Gravity from the QFT Perspective**, Instituto de Física Teórica	*Brazil*
2019	**4th Joint Dutch-Brazil School on Theoretical Physics**, Instituto de Física Teórica	*Brazil*
2018	**Random Physical Systems**, Mathematical Physics Month	*Chile*
2018	**Journeys Into Theoretical Physics**, Instituto de Física Teórica	*Brazil*
2018	**Noncommutative Geometry and Poisson Geometry Around Groupoids**, Pontificia Universidad Javeriana	*Colombia*
2018	**Topological Order and Beyond**, Universidad de los Andes	*Colombia*
2017	**Dynamics of Quantum Systems Outside of Equilibrium**, Universidad de los Andes	*Colombia*

Additional Skills

Programming Languages Python, Julia, Mathematica, Bash, C++, LaTeX, Git

Spanish (native), English (TOEFL 120/120), Portuguese (proficiency exam of the Instituto de Física Teórica).