

Mateus Araújo

Curriculum vitae

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Birth: 1988-08-13
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Research Interests

Quantum Information, Causal Structures, Foundations of Quantum Mechanics

Education & Career

- 2023–present **Postdoctoral researcher**, *University of Valladolid*
- 2022–2023 **Postdoctoral researcher**, *IQOQI-Vienna*
- 2019–2022 **Postdoctoral researcher**, *Austrian Academy of Sciences*, Erwin Schrödinger Quantum Fellowship
- 2017–2019 **Postdoctoral researcher**, *University of Cologne*
- 2012–2016 **PhD in Physics**, *University of Vienna*, “Quantum computation with indefinite causal structures”, supervised by Časlav Brukner
- 2010–2012 **MSc in Physics**, *Federal University of Minas Gerais*, “Quantum realism and quantum surrealism”, supervised by Marcelo Terra Cunha
- 2007–2010 **BSc in Physics**, *Federal University of Minas Gerais*, “Fundamentos matemáticos da separabilidade quântica”, supervised by Marcelo Terra Cunha

Languages

Portuguese	Native	English	Fluent
Spanish	Fluent	German	Fluent
French	Basic		

Teaching

- WS 2023 **Información y Computación Cuántica**, *Lecture*, University of Valladolid, role: Lecturer
- SS 2022 **Quantum Information Theory II**, *Lecture*, TU Wien, role: Lecturer
<https://tiss.tuwien.ac.at/course/courseDetails.xhtml?dswid=3557&dsrid=819&courseNr=141B21&semester=2022S>
- WS 2021 **Quantum Information Theory**, *Lecture*, TU Wien, role: Lecturer
<https://tiss.tuwien.ac.at/course/courseDetails.xhtml?dswid=5444&dsrid=661&courseNr=141B09&semester=2021W>

- SS 2019 **Quantenmechanik (BA)**, *Lecture*, University of Cologne, role: Übungsleiter
<http://www.thp.uni-koeln.de/gross/qm-summer19.html>
- WS 2018 **Quantum Computing Architectures**, *Seminar*, University of Cologne, role: organizer
<http://www.thp.uni-koeln.de/gross qc-seminar-winter18.html>
- SS 2018 **Quantum Information Theory**, *Lecture*, University of Cologne, role: Übungsleiter
<http://www.thp.uni-koeln.de/gross/qi-summer18.html>
- WS 2017 **Interpretations of Quantum Mechanics**, *Seminar*, University of Cologne, role: organizer
<http://www.thp.uni-koeln.de/gross/interpretations-winter17.html>
- SS 2017 **Quantenmechanik (BA)**, *Lecture*, University of Cologne, role: Übungsleiter
<http://www.thp.uni-koeln.de/gross/qm-summer17.html>

Supervisions

- 2023–present **Aplicaciones de optimización en conos no simétricos en comunicación cuántica**, *PhD thesis*, Andrés González Lorente, University of Valladolid
- 2023–present **Desigualdades de Bell con pos-selección**, *Master's thesis*, Víctor Calleja Rodríguez, University of Valladolid
- 2023–present **Demostraciones de la regla de Born**, *Bachelor thesis*, Alejandro Merino Ruiz, University of Valladolid
- 2023–present **Distribución cuántica de claves con ruido realista**, *Bachelor thesis*, María Fadrique Gutierrez, University of Valladolid
- 2023–present **Poder estadístico de las desigualdades de Bell**, *Bachelor thesis*, Daniel Giraldo García, University of Valladolid
- 2023–present **Statistical power of multipartite Bell inequalities**, *Master's thesis*, Philip Neusser, University of Vienna
- 2022–2023 **Quantum key distribution against extreme noise effect using high dimensional entanglement with MUB**, *Master's thesis*, Thomas Uglab, University of Vienna
- 2018 **Interaction-free measurements**, *Bachelor thesis*, Tjark Eilts, University of Cologne
- 2018 **Alternatives to the Born Rule**, *Bachelor thesis*, Stefanie Legler, University of Cologne
- 2017 **Characterizing Quantum Correlations in the I_{3322} Setting**, *Bachelor thesis*, Paula Belzig, University of Cologne

Conference Organization

Tsirelson Memorial Workshop, 2022-04-04 – 2022-04-08, Wien, Austria, <https://tsirelson.iqoqi.oeaw.ac.at/>

Presentations

Conference talks

- *Quantum key distribution rates from semidefinite programming* at IXth International Workshop "New Challenges in Quantum Mechanics: Integrability, Supersymmetry and Quantum Technologies" – 2023-09-29. Valladolid, Spain
- *Quantum key distribution rates from semidefinite programming* at CEQIP 2023 – 2023-09-06. Smolenice, Slovakia
- *Collapse of the Lasserre and NPA hierarchies in the 222 Bell scenario* at Polynomial Quantum Optimization mini-workshop – 2023-05-10. Köln, Germany
- *Bell's theorem, Many-Worlds, and quantum key distribution* at The Many-Worlds Interpretation of Quantum Mechanics – 2022-10-19. Tel Aviv, Israel
- *Statistical sins* at Quantum Confessions – 2022-08-01. Mehedeby, Sweden
- *Interpretations of quantum mechanics* at Just QUIT – 2021-09-08
- *Optimizing Bell inequalities* at SFB BeyondC Autumn Workshop 2021 – 2021-09-03. Innsbruck, Austria
- *Bell nonlocality with a single shot* at Q-turn 2020 – 2020-11-26. Online
- *Quantum computation with indefinite causal structures* at Causality in the quantum world – 2019-09-16. Anacapri, Italy
- *Optimal probabilistic implementation of any linear supermap* at Quantum Maiwar – 2018-11-07. Brisbane, Australia
- *Quantum computation with indefinite causal structures* at Modern Topics in Quantum Information – 2018-08-01. Natal, Brazil
- *Probabilities in two deterministic universes* at Towards Ultimate Quantum Theory – 2018-06-11. Växjö, Sweden
- *A purification postulate for quantum mechanics with no causal order* at VI Quantum Information School and Workshop – 2017-08-22. Paraty, Brazil
- *Quantum computation with indefinite causal structures* at Quantum Correlations in Space and Time – 2017-12-13. Bad Honnef, Germany
- *Characterizing finite-dimensional quantum behavior* at Mathematical Optimization and Quantum Information Theory – 2017-08-07. Bad Honnef, Germany
- *Quantum computation with indefinite causal structures* at Quantum Networks – 2017-08-04. Oxford, United Kingdom
- *Quantum computation with indefinite causal structures* at Quantum Information – 2017-06. Benasque, Spain
- *Quantum computation with indefinite causal structures* at Rhineland Quantum Information Network meeting – 2017-06-06. Köln, Germany
- *Quantum computation with linear closed timelike curves* at Quantum Networks – 2016-11-21. Natal, Brazil
- *A purification postulate for quantum mechanics with no causal order* at CEQIP – 2016-06-19. Valtice, Czech Republic
- *A purification postulate for quantum mechanics with no causal order* at Quantum Networks – 2016-04-01. Barcelona, Spain
- *Witnessing causal nonseparability* at V Quantum Information School and Workshop – 2015-08-12. Paraty, Brazil
- *Witnessing causal nonseparability* at Quantum Information – 2015-06. Benasque, Spain

- *Computational advantage from quantum-controlled ordering of gates* at SFB Meeting – 2014-12-11. Wien, Austria
- *Decrease in query complexity for quantum computers with superposition of circuits* at 78. Jahrestagung der DPG und DPG-Frühjahrstagung – 2014-03-21, Berlin, Germany
- *Conditions of possible experience* at FQXi Workshop on Quantum Contextuality and Sequential Measurements – 2013-11-06. Sevilla, Spain
- *Decrease in query complexity for quantum computers with superposition of circuits* at ÖPG/SPS Annual Meeting 2013 – 2013-09-05. Linz, Austria
- *(Im)possibility of controlling a black box quantum gate* at IV Quantum Information School and Workshop – 2013-08-12. Paraty, Brazil
- *Decrease in query complexity for quantum computers with superposition of circuits* at Quantum Information – 2013-06. Benasque, Spain
- *From the detection loophole to the transmission loophole* at III Encontro temático do INCT-IQ – 2011. Natal, Brazil
- *Maximal CHSH violations with low efficiency photodetection and homodyne measurements* at III Quantum Information School and Workshop – 2011-08-09. Paraty, Brazil
- *Noções de computação quântica* at XXII Escola de Inverno – Física – UFMG – Computação Quântica e Informação Quântica. 2011. Belo Horizonte, Brazil

Talks in scientific visits

- *Quantum key distribution rates from non-symmetric conic optimization* at University of Vigo – 2023-11-24. Vigo, Spain
- *Quantum key distribution rates from non-symmetric conic optimization* at Technical University of Vienna – 2023-11-13. Wien, Austria
- *Bell nonlocality with a single shot* at University of Campinas – 2020-07-07. Campinas, Brazil (online)
- *Probability in many-world theories* at Perimeter Institute – 2019-04-16. Waterloo, Canada
- *Probabilities in two deterministic universes* at University of Vienna – 2018-03-08. Wien, Austria
- *A purification postulate for quantum mechanics with no causal order* at University of Tokyo – 2017-11-07. Tokyo, Japan
- *Probabilidade em dois mundos determinísticos* at Federal University of Minas Gerais – 2016-12-15. Belo Horizonte, Brazil
- *A purification postulate for quantum mechanics with no causal order* at University of Cologne – 2016-08-15. Köln, Germany
- *Quantum computation with linear closed timelike curves* at University of Oxford – 2016-05-10. Oxford, United Kingdom
- *A purification postulate for quantum mechanics with no causal order* at University of Siegen – 2016-04-08. Siegen, Germany
- *Quantum computation with linear closed timelike curves* at Institute of Photonic Sciences – 2016-04-04. Castelldefels, Spain

- *Quantum circuits cannot control unknown operations* at National Quantum Information Centre in Gdańsk – 2013-11-29. Gdańsk, Poland
- *Quantum circuits cannot control unknown operations* at University of Bristol – 2013-10-09. Bristol, United Kingdom
- *(Im)possibility of controlling an arbitrary gate* at Slovak Academy of Sciences – 2013-07-29. Bratislava, Slovakia
- *Contextualidade e negatividade são noções equivalentes de não-classicalidade* at Universidade Federal Fluminense – 2012-08-22. Niterói, Brasil

Internal talks

- *When creepy stuff appears* at Huber group meeting – 2022-02-28. Wien, Austria
- *What does it take to get Born's rule* at Brukner group meeting – 2021-11-12. Wien, Austria
- *Bell nonlocality with a single shot* at Navascués group meeting – 2020-06-16. Wien, Austria
- *Violating a Bell inequality with a single shot* at Huber group meeting – 2020-04-03. Wien, Austria
- *MIP*=RE and the infinity experiment* at Huber journal club – 2020-01-27. Wien, Austria
- *Quantum Supremacy* at Gross journal club – 2019-10-10. Köln, Germany
- *Optimal probabilistic implementation of any linear supermap* at Gross group meeting – 2019-01-10. Köln, Germany
- *Probabilities in (two) deterministic worlds* at IQOQI breakfast – 2016-11-16. Wien, Austria
- *Witnessing causal nonseparability* at IQOQI breakfast – 2015-03-24. Wien, Austria
- *Decrease in query complexity for quantum computers with superposition of circuits* at CoQuS student seminar – 2014-04-07. Wien, Austria

Posters

- *Quantum computation with indefinite causal structures* at CEQIP2017 – 2017-06-01. Smolenice, Slovakia
- *Witnessing causal nonseparability* at QuPoN 2015 – 2015-05-19. Wien, Austria
- *Computational advantage from quantum-controlled ordering of gates* at QIP2015 – 2015-01-13. Sydney, Australia
- *Decrease in query complexity for quantum computers with superposition of circuits*, at Quantum Contextuality, Non-Locality, and the Foundations of Quantum Mechanics – 2014-07-02. Bad Honnef, Germany
- *Quantum circuits cannot control unknown operations*, at Quantum [Un]Speakables II: 50 Years of Bell's Theorem – 2014-19-06. Wien, Austria
- *Quantum circuits cannot control unknown operations* at QIP2014 – 2014-02-04. Barcelona, Spain
- *All noncontextuality inequalities for the n-cylce* at QIP2013 – 2013-02. Beijing, China
- *General bounds for detection efficiency in Bell tests* at TQC2012 – 2012-05. Tokyo, Japan

- *Mapas positivos e testemunhas de emaranhamento* at WECIQ2010 – 2010.
Petrópolis, Brazil

Refereeing

I am a referee for the journals Nature Physics, Nature Communications, Physical Review Letters, Physical Review A, Physical Review D, PRX Quantum, New Journal of Physics, and Quantum.

Publications

Publication list and bibliometrics can be found in [Google Scholar](#), [Scopus](#), [Web of Science](#), and [ORCID](#).

Pre-prints

- [1] M. Araújo, I. Klep, T. Vértesi, A. J. P. Garner, and M. Navascués, "Karush-Kuhn-Tucker conditions for non-commutative optimization problems", (2023), [arXiv:2311.18707 \[quant-ph\]](#).
- [2] A. Tavakoli, A. Pozas-Kerstjens, P. Brown, and M. Araújo, "Semidefinite programming relaxations for quantum correlations", (2023), [arXiv:2307.02551 \[quant-ph\]](#).

Journal Articles

- [3] M. Navascués, K. F. Pál, T. Vértesi, and M. Araújo, "Self-testing in prepare-and-measure scenarios and a robust version of Wigner's theorem", [Phys. Rev. Lett. **131**, 250802 \(2023\)](#), [arXiv:2306.00730 \[quant-ph\]](#).
- [4] M. Araújo, M. Huber, M. Navascués, M. Pivoluska, and A. Tavakoli, "Quantum key distribution rates from semidefinite programming", [Quantum **7**, 1019 \(2023\)](#), [arXiv:2211.05725](#).
- [5] M. Araújo, F. Hirsch, and M. T. Quintino, "Bell nonlocality with a single shot", [Quantum **4**, 353 \(2020\)](#), [arXiv:2005.13418 \[quant-ph\]](#).
- [6] M. M. Taddei, J. Cariñe, D. Martínez, T. García, N. Guerrero, A. A. Abbott, M. Araújo, C. Branciard, E. S. Gómez, S. P. Walborn, L. Aolita, and G. Lima, "Computational advantage from the quantum superposition of multiple temporal orders of photonic gates", [PRX Quantum **2**, 010320 \(2021\)](#), [arXiv:2002.07817 \[quant-ph\]](#).
- [7] J. Bavaresco, M. Araújo, Č. Brukner, and M. Túlio Quintino, "Semi-device-independent certification of indefinite causal order", [Quantum **3**, 176 \(2019\)](#), [arXiv:1903.10526 \[quant-ph\]](#).
- [8] M. Araújo, "Probability in two deterministic universes", [Found. Phys. **49**, 202–231 \(2019\)](#), [arXiv:1805.01753 \[quant-ph\]](#).
- [9] G. Rubino, L. A. Rozema, F. Massa, M. Araújo, M. Zych, Č. Brukner, and P. Walther, "Experimental entanglement of temporal order", [Quantum **6**, 621 \(2022\)](#), [arXiv:1712.06884 \[quant-ph\]](#).
- [10] M. Araújo, P. Allard Guérin, and Á. Baumeler, "Quantum computation with indefinite causal structures", [Phys. Rev. A **96**, 052315 \(2017\)](#), [arXiv:1706.09854 \[quant-ph\]](#).
- [11] M. Araújo, A. Feix, M. Navascués, and Č. Brukner, "A purification postulate for quantum mechanics with indefinite causal order", [Quantum **1**, 10 \(2017\)](#), [arXiv:1611.08535 \[quant-ph\]](#).
- [12] G. Rubino, L. A. Rozema, A. Feix, M. Araújo, J. M. Zeuner, L. M. Procopio, Č. Brukner, and P. Walther, "Experimental verification of an indefinite causal order", [Sci. Adv. **3**, 1602589 \(2017\)](#), [arXiv:1608.01683 \[quant-ph\]](#).
- [13] P. Allard Guérin, A. Feix, M. Araújo, and Č. Brukner, "Exponential communication complexity advantage from quantum superposition of the direction of communication", [Phys. Rev. Lett. **117**, 100502 \(2016\)](#), [arXiv:1605.07372 \[quant-ph\]](#).
- [14] A. Feix, M. Araújo, and Č. Brukner, "Causally nonseparable processes admitting a causal model", [New J. Phys. **18**, 083040 \(2016\)](#), [arXiv:1604.03391 \[quant-ph\]](#).

- [15] C. Branciard, M. Araújo, A. Feix, F. Costa, and Č. Brukner, “The simplest causal inequalities and their violation”, *New J. Phys.* **18**, 013008 (2015), arXiv:1508.01704 [quant-ph].
- [16] A. Feix, M. Araújo, and Č. Brukner, “Quantum superposition of the order of parties as a communication resource”, *Phys. Rev. A* **92**, 052326 (2015), arXiv:1508.07840 [quant-ph].
- [17] M. Navascués, A. Feix, M. Araújo, and T. Vértesi, “Characterizing finite-dimensional quantum behavior”, *Phys. Rev. A* **92**, 042117 (2015), arXiv:1507.07521 [quant-ph].
- [18] M. Araújo, C. Branciard, F. Costa, A. Feix, C. Giarmatzi, and Č. Brukner, “Witnessing causal nonseparability”, *New J. Phys.* **17**, 102001 (2015), arXiv:1506.03776 [quant-ph].
- [19] L. M. Procopio, A. Moqanaki, M. Araújo, F. Costa, I. A. Calafell, E. G. Dowd, D. R. Hamel, L. A. Rozema, Č. Brukner, and P. Walther, “Experimental superposition of orders of quantum gates”, *Nat. Commun.* **6**, 7913 (2015), arXiv:1412.4006 [quant-ph].
- [20] M. Araújo, F. Costa, and Č. Brukner, “Computational Advantage from Quantum-Controlled Ordering of Gates”, *Phys. Rev. Lett.* **113**, 250402 (2014), arXiv:1401.8127 [quant-ph].
- [21] M. Araújo, A. Feix, F. Costa, and Č. Brukner, “Quantum circuits cannot control unknown operations”, *New J. Phys.* **16**, 093026 (2014), arXiv:1309.7976 [quant-ph].
- [22] G. Borges, M. Carvalho, P.-L. de Assis, J. Ferraz, M. Araújo, A. Cabello, M. T. Cunha, and S. Pádua, “Quantum contextuality in a young-type interference experiment”, *Phys. Rev. A* **89**, 052106 (2014), arXiv:1304.4512 [quant-ph].
- [23] M. Araújo, M. T. Quintino, C. Budroni, M. Terra Cunha, and A. Cabello, “All noncontextuality inequalities for the n -cycle scenario”, *Phys. Rev. A* **88**, 022118 (2013), arXiv:1206.3212 [quant-ph].
- [24] C. Teo, M. Araújo, M. T. Quintino, J. Minář, D. Cavalcanti, V. Scarani, M. Terra Cunha, and M. França Santos, “Realistic loophole-free Bell test with atom-photon entanglement”, *Nature Comm.* **4**, 2104 (2013), arXiv:1206.0074 [quant-ph].
- [25] M. Araújo, M. T. Quintino, D. Cavalcanti, M. França Santos, A. Cabello, and M. Terra Cunha, “Tests of Bell inequality with arbitrarily low photodetection efficiency and homodyne measurements”, *Phys. Rev. A* **86**, 030101 (2012), arXiv:1112.1719 [quant-ph].
- [26] M. T. Quintino, M. Araújo, D. Cavalcanti, M. França Santos, and M. Terra Cunha, “Maximal violations and efficiency requirements for Bell tests with photodetection and homodyne measurements”, *J. Phys. A: Math. Theor.* **45**, 215308 (2012), arXiv:1106.2486 [quant-ph].

Comments

- [27] M. Araújo, “Comment on “Geometry of the quantum set on no-signaling faces””, *Phys. Rev. A* **107**, 036201 (2023), arXiv:2302.03529.
- [28] M. Araújo, P. Grangier, and J.-Å. Larsson, “Comment on “The photon identification loophole in EPRB experiments: computer models with single-wing selection””, (2018), arXiv:1807.04999 [quant-ph].

Theses

- [29] M. Araújo, “Quantum computation with indefinite causal structures”, PhD thesis (2016), <http://othes.univie.ac.at/45138/>.
- [30] M. Araújo, “Quantum realism and quantum surrealism”, Master’s thesis (2012), arXiv:1208.6283 [quant-ph].

- [31] M. Araújo, “Fundamentos matemáticos da separabilidade quântica”, Presented at IMPA (in Portuguese), Monografia (2010), http://mateusaraudo.info/monografia_online.pdf.