# Curriculum Vitae ~ Gemma De les Coves

## Contact Details



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# Career

## Employment

| | |
|---|---|
| 10/2024 – Present | ICREA Research Professor at Universitat Pompeu Fabra (UPF), Barcelona |
| 09/2024 | Lecturer at Departament d'Enginyeria, UPF |
| 03/2023 – 08/2024 | Associate Professor at the University of Innsbruck (tenured) |
| 2018 – 02/2023 | Assistant Professor at the University of Innsbruck (tenure-track) |
| 2018 – Present | Group leader of the De les Coves group |
| 2016 – 2018 | Elise Richter Fellow at the Institute of Theoretical Physics of the University of Innsbruck |
| 2011 – 2016 | Postdoc at the Theory Division of the Max Planck Institute for Quantum Optics (MPQ) led by Prof. J. Ignacio Cirac (2012 – 2013 as an Alexander von Humboldt Fellow) |
| Career breaks | Summer 2017 and Spring 2026 (birth of my two daughters) |

## Education & Qualifications

| | |
|---|---|
| 2024 | Acreditació de Recerca (Professora agregada) de l'Agència per a la Qualitat del sistema Universitari (AQU) |
| 2022 | Habilitation in Theoretical Physics<br>entitled *Quantum Theory: From the Whole to the Parts, Magic Squares & Shadows of Infinity* |
| 2007 – 2011 | PhD in Theoretical Physics at the University of Innsbruck supervised by Prof. Hans J. Briegel<br>("1.0 mit Auszeichnung" and PhD Prize of the German Physical Society of 2012) |
| 2006 – 2007 | Master Thesis at the Universitat Autònoma de Barcelona supervised by Prof. Jordi Faraudo<br>in collaboration with Sepmag ("Matrícula d'Honor") |
| 2002 – 2007 | "Llicenciada" in Physics, Universitat Autònoma de Barcelona |

## Honors

| | |
|---|---|
| 2024 | Visiting Professor at Universitat Pompeu Fabra (Catalonia) |
| 2021 – 2024 | Visiting Fellow at the Perimeter Institute for Theoretical Physics (Canada) |
| 2021 – 2024 | Member of the Young Academy of the Austrian Academy of Sciences (UIBK news) |
| 2020 | START Prize of the Austrian Science Fund (FWF) (UIBK news, Der Standard, Falter Heureka) |
| 2016 – 2017 | Emmy Noether Visiting Fellow of the Perimeter Institute for Theoretical Physics (Canada) |
| 2012 | PhD Prize (SAMOP-Dissertationspreis) of the German Physical Society (IQOQI news, MPQ news) |
| 2005 | First prize to a literary creation related with Physics and publication:<br>Ser i res. Gemma de las Cuevas i Millan. Revista de Física **3**, 20 (2006) |

## Third-Party Funding

2020 START Prize of the FWF (1 042 k€)
2020 Stand Alone Project of the FWF for 4 years (324 k€)
2016 Elise Richter Fellowship of the FWF for 4 years (302 k€)
2012 Alexander von Humboldt Fellowship for PostDoctoral Researchers for 2 years (79 k€)
2006 Undergraduate student fellowship from the Spanish National Research Council (declined)

# Research

## Publications & Preprints

- Author order conventions: In Physics, indicated underlined, the first author did most of the work and the last author directed the project. In Mathematics, indicated dashed underline, authors are sorted alphabetically.
- The five selected publications are marked in **bold**.

P1. Going deep, reaching further: What can Boltzmann machines efficiently represent?
Tobias Reinhart and Gemma De les Coves
arXiv:2610.39731 (2026)

P2. The View from Within: What Can Embedded Observers (Not) Learn?
Tomáš Gonda and Johannes Fankhauser and Gemma De les Coves
arXiv:2608.25800 (2026)

**P3. Universal Spin Models are Universal Approximators in Machine Learning**
Tobias Reinhart and Gemma De les Coves
Physical Review E, **113** L043301 (2026). arXiv:2507.07669

P4. The Structure of Emulations in Classical Spin Models: Modularity and Universality
Tobias Reinhart, Benjamin Engel and Gemma De les Coves
Journal of Mathematical Physics, **67** 073303 (2026). arXiv:2407.13428

**P5. Epistemic Horizons From Deterministic Laws: Lessons From a Nomic Toy Theory**
Johannes Fankhauser, Tomáš Gonda and Gemma De les Coves
Synthese **205**, 136 (2025). arXiv:2406.17581

P6. An Invitation to Universality in Physics, Computer Science, and Beyond
Tomáš Gonda and Gemma De les Coves
arXiv:2406.16607 (2024)
To appear in Category Theory at Work in Computational Mathematics and Theoretical Informatics (CATMI), part of the book series on Fundamental Structures in Computational and Pure Mathematics, published by Birkhäuser–Springer.

P7. Positive Moments Forever: Decidable and Undecidable Cases
Gemma De les Coves, Joshua Graf, Andreas Klingler and Tim Netzer
Linear Algebra and its Applications **722**, 255 (2025). arXiv:2404.15053

P8. Universality and Complexity in Natural Languages: Mechanistic and Emergent
Gemma De les Coves, Bernat Corominas-Murtra and Ricard Solé
Preprint 202402.1330 (2024)

P9. Tensor decompositions on simplicial complexes with invariance
Gemma De las Cuevas, Matt Hoogsteder Riera and Tim Netzer
Journal of Symbolic Computation **124**, 102299 (2024). arXiv:1909.01737

**P10. Beyond Operator Systems**
Gemma De les Coves, Mirte van der Eyden and Tim Netzer
Journal of Mathematical Analysis and Applications **556**, 130102 (2026). arXiv:2312.13983

P11. A Framework for Universality in Physics, Computer Science and Beyond
Tomáš Gonda, Tobias Reinhart, Sebastian Stengele and Gemma De les Coves
Compositionality **6**, No. 3 (2024). arXiv:2307.06851

P12. Border Ranks of Locally Positive and Invariant Tensor Decompositions: Applications to Correlations
Andreas Klingler, Tim Netzer and Gemma De les Coves
Quantum **9**, 1649 (2025). arXiv:2304.13478

P13. Many bounded versions of undecidable problems are NP-hard
Andreas Klingler, Mirte van der Eyden, Sebastian Stengele, Tobias Reinhart and Gemma De las Cuevas
SciPost Physics **14**, 173 (2023). arXiv:2211.13532

P14. Magic squares: Latin, semiclassical and quantum
Gemma De las Cuevas, Tim Netzer and Inga Valentiner-Branth
Journal of Mathematical Physics **64**, 022201 (2023). arXiv:2209.10230

**P15. Classical spin Hamiltonians are context-sensitive languages**
Sebastian Stengele, David Drexel and Gemma De las Cuevas
Proceedings of the Royal Society A **479**, 20220553 (2023). arXiv:2006.03529

P16. The grammar of the Ising model: A new complexity hierarchy
Tobias Reinhart and Gemma De les Coves
Proceedings of the Royal Society A **481**, 20240579 (2025). arXiv:2208.08301

P17. Halos and undecidability of tensor stable positive maps
Mirte van der Eyden, Tim Netzer and Gemma De las Cuevas
Journal of Physics A: Mathematical and Theoretical **55**, 264006 (2022). arXiv:2110.02113

P18. Why can the brain (and not a computer) make sense of the liar paradox?
Patrick T. Fraser, Ricard Solé and Gemma De las Cuevas
Frontiers in Ecology and Evolution **9**, 802300 (2021). Preprint 202111.0524
See blog post by Gerard Milburn

P19. Polynomial decompositions with invariance and positivity inspired by tensors
Gemma De las Cuevas, Andreas Klingler and Tim Netzer
Linear Algebra and its Applications **698**, 537 (2024). arXiv:2109.06680

P20. Quantum Information Theory and Free Semialgebraic Geometry: One Wonderland Through Two Looking Glasses
Gemma De las Cuevas and Tim Netzer
Internationale Mathematische Nachrichten Nr. 246 (2021). arXiv:2102.04240

P21. Cats climb entails mammals move: preserving hyponymy in compositional distributional semantics
Gemma De las Cuevas, Andreas Klingler, Martha Lewis and Tim Netzer
Journal of Cognitive Science **22**, 311 (2021). arXiv:2005.14134
Accepted as a talk for SemSpace2020

P22. Approximate tensor decompositions: disappearance of many separations
Gemma De las Cuevas, Andreas Klingler and Tim Netzer
Journal of Mathematical Physics **62**, 093502 (2021) (Editor's pick). arXiv:2004.10219

P23. On the use of direct-coupling analysis with a reduced alphabet of amino acids combined with super-secondary structure motifs for protein fold prediction
Bernat Anton, Mireia Besalú, Oriol Fornes, Jaume Bonet, Alexis Molina, Ruben Molina-Fernandez, Gemma De las Cuevas, Narcís Fernández-Fuentes and Baldo Oliva
NAR Genomics and Bioinformatics **3**, Issue 2, lqab027 (2021). BioRxiv:10.1101/406603

P24. Quantum magic squares: Dilations and their limitations
Gemma De las Cuevas, Tom Drescher and Tim Netzer
Journal of Mathematical Physics **61**, 111704 (2020) (Featured by the Editor). arXiv:1912.07332
See AIP Scilight, UIBK news, El Periodico, the related Quanta magazine article and my article for El Pais

P25. Generalized ansatz for continuous Matrix Product States
Maria Balanzó-Juandó and Gemma De las Cuevas
Physical Review A **101**, 052312 (2020) (Editor's suggestion). arXiv:1908.09761

P26. Mixed states in one spatial dimension: decompositions and correspondence with nonnegative matrices
Gemma De las Cuevas and Tim Netzer
Journal of Mathematical Physics **61**, 041901 (2020). arXiv:1907.03664

P27. Optimal bounds on the positivity of a matrix from a few moments
Gemma De las Cuevas, Tobias Fritz and Tim Netzer
Communications in Mathematical Physics **375**, 105 (2020). arXiv:1808.09462

P28. Separability for mixed states with operator Schmidt rank two
Gemma De las Cuevas, Tom Drescher and Tim Netzer
Quantum **3**, 203 (2019). arXiv:1903.05373

P29. Continuum limits of Matrix Product States
Gemma De las Cuevas, Norbert Schuch, David Perez-Garcia and J. Ignacio Cirac
Physical Review B **98**, 174303 (2018). arXiv:1708.00880

P30. Irreducible forms for Matrix Product States: Theory and Applications
Gemma De las Cuevas, J. Ignacio Cirac, Norbert Schuch and David Perez-Garcia
Journal of Mathematical Physics **58**, 121901 (2017) (Editor's Pick). arXiv:1708.00029

P31. Energy as a detector of nonlocality of many-body spin systems
J. Tura, G. De las Cuevas, R. Augusiak, M. Lewenstein, A. Acín and J. I. Cirac
Physical Review X, **7**, 021005 (2017). arXiv:1607.06090
See UIBK news

P32. Fundamental limitations in the purifications of tensor networks
G. De las Cuevas, T. S. Cubitt, J. I. Cirac, M. M. Wolf and D. Pérez-García
Journal of Mathematical Physics **57**, 071902 (2016) (Editor's Pick). arXiv:1512.05709

**P33. Simple universal models capture all classical spin physics**
Gemma De las Cuevas and Toby S. Cubitt
Science **351**, 1180 (2016). arXiv:1406.5955
See Article by Adrian Cho, Perspective by Stephanie Wehner, MPQ news, Phys.org

P34. Reducing spacetime to binary information
Silke Weinfurtner, Gemma De las Cuevas, Miguel Angel Martin–Delgado and Hans J. Briegel
Journal of Physics A: Mathematical and Theoretical **47**, 095301 (2014). arXiv:1210.5182

P35. Purifications of multipartite states: limitations and constructive methods
Gemma De las Cuevas, Norbert Schuch, David Pérez-García and J. Ignacio Cirac
New Journal of Physics **15**, 123021 (2013). arXiv:1308.1914

P36. A quantum information approach to statistical mechanics
Gemma De las Cuevas
Journal of Physics B: Atomic, Molecular and Optical Physics **46**, 243001 (2013). arXiv:1312.6007

P37. Projective simulation for artificial intelligence
Hans J. Briegel and Gemma De las Cuevas
Scientific Reports **2**, 400 (2012). arXiv:1104.3787
See Der Standard, Die Presse

P38. Quantum algorithms for classical lattice models
G. De las Cuevas, W. Dür, M. Van den Nest and M. A. Martin–Delgado
New Journal of Physics **13**, 093021 (2011). arXiv:1104.2517

P39. The U(1) Lattice Gauge Theory Universally Connects All Classical Models with Continuous Variables, Including Background Gravity
Ying Xu, Gemma De las Cuevas, Wolfgang Dür, Hans J. Briegel and Miguel Angel Martin–Delgado
Journal of Statistical Mechanics: Theory and Experiment P02013 (2011). arXiv:1010.2041

P40. Mapping all classical spin models to a lattice gauge theory
G. De las Cuevas, W. Dür, H. J. Briegel and M. A. Martin–Delgado
New Journal of Physics **12**, 043014 (2010). arXiv:0911.2096

P41. Unifying All Classical Spin Models in a Lattice Gauge Theory
G. De las Cuevas, W. Dür, H. J. Briegel and M. A. Martin–Delgado
Physical Review Letters **102**, 230502 (2009). arXiv:0812.3583

P42. Completeness of classical spin models and universal quantum computation
G. De las Cuevas, W. Dür, M. Van den Nest and H. J. Briegel
Journal of Statistical Mechanics: Theory and Experiment P07001 (2009). arXiv:0812.2368

P43. Low-Gradient Magnetophoresis through Field-Induced Reversible Aggregation
G. De las Cuevas, J. Faraudo and J. Camacho
Journal of Physical Chemistry C **112**, 945 (2008).

## Book chapters

B1. Universality and unreachability: Power and paradoxes from logic to philosophy
Gemma De les Coves
*The philosophy of rigour* (to appear)
Edited by Dean Rickles and Karim Thebault
Routledge (2026).

B2. Does the past and the future exist? Time, space and determinism
Gemma De les Coves
*The invention of time* (In Catalan, Spanish and English)
Edited by Ricard Solé and Carles Lalueza-Fox
Publicacions del Museu de Ciències Naturals de Barcelona (2026).

B3. Do simples exist? The light shed by computation on an ancient question
Gemma De les Coves
*Quantum Gravity and Computation*
Edited by Dean Rickles, Xerxes D. Arsiwalla and Hatem Elshatlawy
Routledge (2025).

B4. Quantum Theory: Ideals, Infinities and Pluralities
Gemma De les Coves
*Open Systems: Physics, Metaphysics, and Methodology*
Edited by Michael E. Cuffaro and Stephan Hartmann
Oxford University Press (2025).

B5. Ser humà: La ferida de l'infinit. Una trobada íntima de la ciència i la cultura
Gemma De les Coves
*A camp obert. Pràctiques culturals contemporànies*
A cura de Josep Ramoneda and Raül Garrigasait
Institut Ramon Llull & Arcàdia (2024).

English edition:
*Being human: The wound of infinity. An intimate encounter of science and culture*
Gemma De les Coves
*In an Open Field. Contemporary Cultural Practices*
Curated by Josep Ramoneda and Raül Garrigasait
Institut Ramon Llull & Arcàdia (2024).

## INVITED PRESENTATIONS

75. *Universality and unreachability: Power and paradoxes from logic to philosophy*. Natural Philosophy Forum, The Johns Hopkins University, Baltimore, USA. Hosted by Jenann Ismael and Sean Carroll. Oct 9, 2026.

74. *Universality and unreachability in physics, computer science and beyond*. Yale University, New Haven, USA. Hosted by Jack Harris. Oct 6, 2026.

73. *Universality and unreachability in physics, mathematics, computer science and slightly beyond*. Special Session "At the border of universality" at CiE 2026. Trier, Germany. Jul 27, 2026. (Virtual)

72. Panel discussion at *Bridging Philosophy of Science and Quantum Foundations*. FAU$^2$ Workshop: Quantum Gravity Meets Quantum Information – Foundations, Frameworks and Frontiers. Jul 7-9, 2026. (Virtual)

71. *Universality and unreachability in physics, mathematics, computer science and slightly beyond*. UPC, Barcelona. Colloquium hosted by Prof. Eva Miranda. Feb 25, 2026.

70. *Universality and unreachability in physics and beyond*. 4th Complexity Week, Ciudad de Mexico. Oct 28, 2025. Plenary talk followed by panel discussion with Carlos Gershenson, Paul Schrater and Boris Escalante. (Virtual)

69. *Interfaces of Quantum Theory with other disciplines*. Helgoland – 100 years of Quantum Mechanics. Helgoland, The North Sea. Jun 13, 2025.

    Articles by PhysicsWorld, Quanta magazine, Nature, Ara and Video by Lizzie Gibney.

68. *The Ising model: Universality and grammar*. Ising lectures 2025. Lviv, Ukraine (hosted by Yurij Horovatch). May 14, 2025. (Virtual)

67. *Universality in physics, computer science and beyond*. Dutch Institute for Emergent Phenomena. Amsterdam, Netherlands (hosted by Abel Jansma). Mar 6, 2025.

66. *Quantum Theory: Ideals, Infinities and Pluralities*. New Approaches to the Foundations of Quantum Mechanics. Vadstena Monastery, Sweden. Nov 27 to 30, 2024.

65. *Lectures on Quantum Information* (5 hours). School on Selected Topics in Quantum Groups, Quantum Information and Operator Algebras. Isaac Newton Institute for Mathematical Sciences, Cambridge, UK. Nov 4 to 8, 2024.

64. *Universality in physics, computer science and beyond*. Colloquium at the Johannes Kepler University (hosted by Johannes Kofler), Linz, Austria. Feb 19, 2024.

63. *Universality in Physics, Computer Science and Beyond*. DTIC, UPF, Barcelona. Oct 27, 2023.

62. *Universality, Lawvere's Theorem & Unreachability*. Hot Topics: MIP*=RE and the Connes Embedding Problem, Simons Laufer Mathematical Sciences Institute, Berkeley, California. Oct 20, 2023.

61. *Què és l'art?* Palau Macaya, Barcelona. With Josep Ramoneda, Jaume Casals, Genoveva Martí, Ricard Solé, Ramon López de Mántaras, Pol Guasch, Carolina Ciuti and Mireia Sallarès (see this video of our debate at Caixaforum+). Jun 14 to 15, 2023.

60. *Universality & Unreachability*. New Directions in the Foundations of Physics. Viterbo, Italy. May 27, 2023.

59. *No system can talk about itself — Yet here we are. On why the brain can make sense of the liar paradox.* Wigner's Friends: Theory Workshop. San Francisco, California. Dec 2, 2022.

58. *Universality, undecidability and Wigner's friend.* Wigner's Friends: Theory Workshop. San Francisco, California. Dec 1, 2022.

57. *What is the reach of universality & undecidability?* Measurement-Based Quantum Computation, Agency and Learning (In honor of Hans Briegel's 60th birthday). Obergurgl, Austria. Aug 30, 2022.

56. *Quantum Theory: From the Whole to the Parts, Magic Squares, and Shadows of Infinity*. Habilitation Talk at the UIBK. Jul 7, 2022.

55. *What is the reach of universality & undecidability?* Quantum Information workshop. Seefeld in Tirol, Austria. Jun 27 to Jul 1, 2022.

54. *Universality & Undecidability*. Solstice of Foundations (Summer School). ETH Zürich. Jun 21, 2022.

53. *What is the reach of universality & undecidability?* Quantum Natural Language Processing 2022. Oxford, UK. May 30, 2022.

52. *What is the reach of universality & undecidability?* First Lie–Størmer Colloquium. Rosendal, Norway. May 26, 2022.

51. *What does universal mean? And what is the scope of universality & undecidability across disciplines?* Entangled states of matter. Berlin, Germany. May 2 to 9, 2022.

50. *What does universal mean? An exploration at the intersection of physics, linguistics and beyond* (In Catalan) Roger Martin Lecture at the UAB. Mar 10, 2022. (Virtual)

49. *Quantum theory: From the whole to the parts, magic squares, and shadows of infinity*. Center for Theoretical Physics, Polish Academy of Sciences, Warsaw (hosted by Remigiusz Augusiak). Feb 24, 2022. (Virtual)

48. *Quantum Theory: From the Whole to the Parts, Magic Squares, and Shadows of Infinity*. Theory Colloquium at the UIBK. Dec 15, 2021. (Virtual)

47. *Physics & Computer science: The Actual & the Possible*. Philosophy Colloquium at the University of Konstanz (hosted by Thomas Müller), Germany. Dec 1, 2021.

46. *From simplicity to universality and undecidability*. VQC Colloquium, Vienna. Nov 22, 2021. (Virtual)

45. *Què és la realitat?* Palau Macaya, Barcelona. With Josep Ramoneda, Tomàs Marquès, Jaume Casals, Jordi Camí, Carolina Ciuti, Ana-Carolina Gutiérrez-Xivillé and Sergi Valverde. Oct 27 and 28, 2021.

44. *From simplicity to universality and undecidability*. DIPC Donostia (hosted by Román Orús). Oct 15, 2021. (Virtual)

43. *From simplicity to universality and undecidability*. New York City Category Theory Seminar (hosted by Noson Yanofsky). Oct 7, 2021. (Virtual)

42. *General decompositions with invariance, positivity and approximations*. Geometry and Optimization in Quantum Information. Oberwolfach, Germany. Oct 6, 2021. (Virtual)

41. *Classical spin Hamiltonians are context-sensitive languages*. Science Day of the Young Academy of the ÖAW. Vienna. Sep 23, 2021. (Virtual)

40. *General decompositions with invariance, positivity and approximations*. Minisymposium on geometric aspects of tensor networks at SIAM AG21. Texas A&M, USA. Aug 19, 2021. (Virtual)

39. *From simplicity to universality and undecidability*. Workshop on Quantum Entanglement and Emergent Phenomena, Tsung-Dao Lee Institute. Shanghai, China. Aug 18, 2021. (Virtual)

38. *Positivity wants to break free*. Tensor Networks: Quantum Physics, Geometry and Applications, CIRM workshop, Levico, Trento. Jul 26 to 28, 2021.

37. *Computational complexity for physicists*. DK ALM Summer school, Achensee, Austria. Jul 13, 2021.

36. *From simplicity to universality*. Physics Colloquium at Johannes Kepler University (hosted by Kurt Hingerl), Linz, Austria. Jun 21, 2021.

35. *From simplicity to universality*. TEDx FHKufstein. Kufstein, Austria. Jun 2021.

34. *The unbearable lightness of universality and undecidability*. Miniworkshop with Tom Sterkenburg entitled "Universality and Undecidability in Physics and Machine Learning" at the Munich Center for Mathematical Philosophy. Apr 21, 2021. (Virtual)

33. Dialogue with Wolfram Hinzen and the Grammar and Cognition Lab (UPF Barcelona) on W. Hinzen's and M. Sheehan's book *The Philosophy of Universal Grammar*. Apr 6, 2021. (Virtual)

32. *Universality everywhere: From spin models to automata and beyond*. Quantum Information Group at the UAB. Mar 11, 2021. (Virtual)

31. *Universality everywhere: From spin models to automata and beyond*. SFB BeyondC Winter Workshop. Innsbruck. Feb 16 and 17, 2021. (Virtual)

30. *Universality in spin models, automata, neural networks and beyond*. Physics Colloquium at Johannes Kepler University, Linz, Austria. Dec 9, 2020. (Virtual)

29. *Universality in spin models, automata, neural networks and beyond*. Philosophy Colloquium at the University of Konstanz (hosted by Thomas Müller), Germany. Dec 3, 2020. (Virtual)

28. *Universality in spin models, automata, neural networks, and beyond*. Institute of Cross-disciplinary Physics and Complex Systems (hosted by Tobias Galla), Mallorca. Oct 21, 2020. (Virtual)

27. *Universality in spin models, automata and neural networks*, Quantum Natural Language Processing. Oxford, UK. Sep 21, 2020. (Virtual)

26. *Universality Everywhere: From spin models to automata*. ISTA, Vienna. Jan 16, 2020.

25. *Local descriptions of mixed states*. University Toulouse III – Paul Sabatier. Dec 12, 2019.

24. *Universality: From spin models to automata*. Quantum Natural Language Processing. Oxford, UK. Dec 5 to 6, 2019.

23. *Local descriptions of mixed states*. Focus week on tensor networks. ICMAT, Madrid. Sep 17 to 20, 2019.

22. *Local descriptions of mixed states*. Analytical and Combinatorial Aspects of Quantum Information Theory. ICMS, Edinburgh, Scotland. Sep 9 to 13, 2019.

21. *Mixed states: Challenges & New results*. Quantum Simulation: Gauge fields, Holography and Topology. Bilbao. Jul 10, 2019.

20. *Mixed states with tensor networks: Challenges & New results*. SFB-FoQus International Conference. Innsbruck. Feb 9, 2019.

19. *On the concept of universality: Ubiquity and limitations*. Annual Meeting of the Swiss Society for Logic and the Philosophy of Science. Lugano, Switzerland. Sep 22, 2018.

18. *An introduction to tensor networks*. Introductory Course on Quantum Information. UIBK. Jul 11, 2018.

17. *Matrix Product States: Continuum limits and irreducible forms*. QuICS, University of Maryland, USA. May 2, 2018.

16. *On the concepts of universality in physics and computer science*. Algorithmic Information, Induction and Observers in Physics. Perimeter Institute, Canada. Apr 9 to 13, 2018.

15. *Matrix Product States: Irreducible Forms and Continuum limits*. Quantum Innovators in Computer Science and Mathematics. IQC, Waterloo, Canada. Sep 18 to 21, 2017.

14. *An Introduction to Tensor Networks*. Introductory Course on Quantum Information. UIBK. Jul 12 to 14, 2016.

13. *Simple universal models capture all classical spin physics*. Last Frontiers in Quantum Information Science 4. Juneau, Alaska, USA. Jun 20 to 24, 2016.

12. *Simple universal models capture all classical spin physics*. Johannes Gutenberg University, Mainz, Germany. May 20, 2016.

11. *Simple universal models capture all classical spin physics*. Quantum simulations: Theory meets experiment – A workshop for young researchers. Oxford, UK. Oct 30 to 31, 2015.

10. *Which states have a continuum limit?* Perimeter Institute, Canada. May 11 to 17, 2015.

9. *Which discrete states have a continuum limit?* Coogee Workshop. Sydney, Australia. Jan 21 to 23, 2015.

8. *Simple universal models capture all spin physics*. Quantum Information workshop. Seefeld in Tirol, Austria. Jun 29 to Jul 4, 2014.

7. *Universal Hamiltonian simulators: the full characterization*. Perimeter Institute, Canada. Nov 11, 2013.

6. *Bounding the purification rank of mixed states*. Perimeter Institute, Canada. Feb 25, 2013.

5. *Reducing spacetime to binary information*. 6th AFI Symposium on Gravitational Puzzles. Innsbruck. Dec 7, 2012.

4. *A quantum information approach to statistical mechanics*. DPG Frühjahrstagung. Stuttgart, Germany. Mar 12, 2012.

3. *A quantum information approach to statistical mechanics*. El Escorial Summer School 2011: Quantum Information meets Statistical Mechanics. El Escorial, Madrid. Jul 11 to 15, 2011.

2. *A quantum information approach to discrete quantum gravity*. Utrecht University, The Netherlands. May 30, 2011.

1. *Unifying all classical spin models using a quantum formalism*. Workshop on Quantum Algorithms, Computational Models, and Foundations of Quantum Mechanics. University of British Columbia, Vancouver, Canada. Jul 23 to 25, 2010.

## Talks in Conferences & Workshops

18. *Universalities in natural languages*. SemSpace 2021. Jun 16, 2021. (Virtual)

17. *Cats climb entails mammals move: preserving hyponymy in distributional semantics*. SemSpace 2020. Aug 7, 2020. (Virtual)

16. *On Open and Closed Quantum Systems*. Symposium on Open quantum systems, held together with Michael E. Cuffaro, Stephan Hartmann and Jos Uffink. British Society for the Philosophy of Science Annual Conference. Oxford, UK. Jul 5 and 6, 2018.

15. *Representing continuum limits of matrix product states*. Optimising, Renormalising, Evolving and Quantising Tensor Networks. Max Planck Institute for the Physics of Complex Systems, Dresden, Germany. Jun 18 to 20, 2018.

14. *Continuous limits of matrix product states*. MPQ Theory Group Workshop. Ötz, Austria. May 2 to 4, 2016.

13. *Lower bounds on the purification rank, and perturbations of the separation*. Open problems workshop. Institute of Advanced Studies, TUM, Garching, Germany. Apr 13, 2015

12. *Progress report of the MPQ Theory Division*. SIQS 2015 Workshop. ICFO, Barcelona. Mar 18 to 20, 2015.

11. *Fundamental limitations of purification problems*. Quantum Computation, Quantum Information and the Exact Sciences. LMU, Munich, Germany. Jan 30, 2015.

10. *Which discrete states have a continuum limit?* MPQ Theory Group Workshop. Passau, Germany. Nov 27, 2014.

9. *Purifications of multipartite states: limitations and constructive methods*. Quantum Information Processing (QIP), Barcelona. Feb 3 to 7, 2014.

8. *Triggering Markovianity of Quantum Channels*, MPQ Theory Group Workshop. Kitzbühel, Austria. Dec 11 to 14, 2013.

7. *Mixed states decomposition: Tensor networks and beyond*. Joint MPQ – ICFO workshop. Barcelona. May 22 to 24, 2013.

6. *On Matrix Product Density Operators*. MPQ Theory Group Workshop. Friedrichshafen, Germany. Sep 12 to 14, 2012.

5. *Mappings of the partition function using a quantum formulation*. Fifth International Workshop DICE2010. Castiglioncello, Italy. Sep 13 to 17, 2010.

4. *Unifying all classical spin models in a lattice gauge theory*. SFB FoQuS meeting. Vienna. Apr 24, 2009.

3. *Unifying all classical spin models in a lattice gauge theory*. DPG Frühjahrstagung. Hamburg, Germany. Mar 2 to 6, 2009.

2. *Completeness of classical spin models and universal quantum computation*. The mathematical foundations of quantum control and quantum information theory. Madrid. May 26 to 30, 2008.

1. *Completeness of classical spin models and universal quantum computation*. DPG Frühjahrstagung. Darmstadt, Germany. Mar 10 to 14, 2008.

## SEMINARS

48. *Lawvere's theorem: motivation and instances*. Seminar for Jenann Ismael's group. Department of Philosophy, The Johns Hopkins University, Baltimore, USA. Oct 8, 2026.

47. *The scope of universality and unreachability*. Seminar for the Artificial Intelligence and Machine Learning group at UPF, Barcelona. Nov 3, 2025.

46. *The scope of universality and unreachability*. Seminar for the Quantum Information group at ETH Zürich (Prof. Renato Renner), Switzerland. Sep 3, 2025.

45. *Universality and Complexity in Natural Languages: Mechanistic and Emergent*. Seminar for the Computational Linguistics group in Universitat Pompeu Fabra, Barcelona. Feb 19, 2025.

44. *Universality in Physics, Computer Science and Beyond*. Centre for Brain and Cognition, hosted by Gustavo Deco. Universitat Pompeu Fabra, Catalonia. Dec 4, 2024.

43. *The grammar of machines and spin models*. Seminar for Bernat Corominas-Murtra's group at the University of Graz, Austria. May 7, 2021. (Virtual)

42. *Universality everywhere: From spin models to automata, and beyond*. Seminar for Manlio De Domenico's group in Trento. Mar 3, 2021. (Virtual)

41. *Universality in spin models, automata, neural networks, and beyond*. Seminar for Lídia del Rio, Nuriya Nurgalieva and the Quantum Information Group at ETH Zürich, Switzerland. Nov 23, 2020. (Virtual)

40. *Universality in spin models, automata, neural networks, and beyond*. Seminar for the Computer Science Department of the UIBK. Nov 19, 2020. (Virtual)

39. *Universality in spin models, automata, neural networks and beyond*. Seminar for Hans Briegel's group at the UIBK. Nov 11, 2020. (Virtual)

38. *Universality in spin models, automata, neural networks and beyond*. Seminar for Roger Melko's Group at the University of Waterloo & Perimeter Institute, Canada. Oct 27, 2020. (Virtual)

37. *A different logic for the assumptions of the world*. Joint group retreat of the Algebra Group and Our Group. Maria Waldrast, Austria. Feb 21, 2020.

36. *Non-axiomatic formal systems?* Joint group retreat of the Algebra Group and Our Group. Maria Waldrast, Austria. Feb 21, 2020.

35. *Universality: From spin models to automata*. Seminar for the Complex Systems Lab hosted by Ricard Solé. PRBB, Barcelona. Nov 4, 2019.

34. *Local descriptions of mixed states*. Seminar for Časlav Brukner's group. IQOQI Vienna. Aug 13, 2019.

33. *On decompositions of quantum states and nonnegative matrices*. Seminar for Hans Briegel's group. UIBK. Mar 20, 2019.

32. *The positivity problem in quantum many-body systems*. Seminar for Časlav Brukner's group. IQOQI Vienna. Oct 8, 2018.

31. *The positivity problem in quantum many-body systems & Universality in physics and computer science*. Seminar at the Institute for Theoretical Physics at the UIBK. Sep 17, 2018.

30. *Universality in spin systems*. QuICS, University of Maryland, USA. May 2, 2018.

29. *Matrix Product States: Irreducible forms and Continuum limits*. Seminar hosted by Aske Plaat at the University of Leiden, The Netherlands. Jan 25, 2018.

28. *Matrix Product States: Irreducible forms and continuum limits*, Seminar for the Quantum Information Group of the UAB, Bellaterra, Catalonia. Dec 18, 2017.

27. *Simple universal models capture all classical spin physics*. Seminar for Alejandro Lage Castellano's group at the University of Havana, Cuba. Nov 2, 2017.

26. *Some open problems in representing mixed states with tensor networks*. Seminar at the Institute for Theoretical Physics at the UIBK. Oct 5, 2016.

25. *Simple universal models capture all classical spin physics*. ICFO, Barcelona, Catalonia. Jul 18, 2016.

24. *Which discrete states have a continuum limit?* Seminar for Simone Montangero's group at Ulm University, Germany. Nov 5, 2015.

23. *Which discrete states have a continuum limit?* Seminar for the Quantum Information Group of the UAB, Bellaterra, Catalonia. Sep 29, 2015.

22. *On positivity and tensor networks*. Seminar for Tobias Osborne's group at the Institute for Theoretical Physics of the Leibniz Universität Hannover, Germany. Jul 16, 2015.

21. *Which discrete states have a continuum limit?* Seminar at the Institute for Theoretical Physics at the UIBK and IQOQI Innsbruck. Jun 17, 2015.

20. *Purifications of multipartite states: Limitations and constructive methods*. Seminar for Ulrich Schollwöck's group at the LMU Munich, Germany. Oct 22, 2014.

19. *Purifications of multipartite states: Limitations, constructive methods and connections to other fields*, Seminar at the Centre for Quantum Information and Foundations at the University of Cambridge, UK. Oct 9, 2014.

18. *Purifications of multipartite states: Limitations and constructive methods*. Seminar for Miguel Angel Martin–Delgado's group at the Complutense University of Madrid. Apr 9, 2014.

17. *On universal Hamiltonian simulators*. Seminar at the Institute for Theoretical Physics at the UIBK and IQOQI Innsbruck. Mar 3, 2014.

16. *Purifications of multipartite states: Limitations and constructive methods*. Seminar for Ronald de Wolf's group at CWI Amsterdam, The Netherlands. Feb 10, 2014.

15. *Purifications of multipartite states: Limitations and constructive methods*. Seminar for the Quantum Information Group of the UAB, Bellaterra, Catalonia. Oct 29, 2013.

14. *Part I: Mixed state decompositions: Tensor Networks and beyond. Part II: NP-hard spin models can simulate any other model*. Seminar at the Institute for Theoretical Physics at the UIBK. Jun 12, 2013.

13. *Reducing spacetime to binary information*. Seminar for Miguel Angel Martin–Delgado's group at the Complutense University of Madrid. Oct 16, 2012.

12. *A quantum information approach to statistical mechanics*. Seminar at the MPQ, Garching, Germany. May 29, 2012.

11. *A quantum information approach to statistical mechanics*. Seminar for Antonio Acín's group at ICFO, Barcelona, Catalonia. Apr 16, 2012.

10. *Undecidability: A sketch of Gödel's proof*. Seminar at the MPQ, Garching, Germany. Mar 28, 2012.

9. *Quantum algorithms for classical lattice models*. Seminar for Miguel Angel Martin–Delgado's group at the Complutense University of Madrid. Feb 21, 2012.

8. *A quantum information perspective to statistical mechanics*. Seminar for David Perez-Garcia's group at the Instituto de Ciencias Matemáticas (ICMAT), Madrid. Feb 21, 2012.

7. *A quantum information perspective to statistical mechanical problems*, Seminar for Ignacio Cirac's group at the MPQ, Garching, Germany. Oct 15, 2010.

6. *Quantum formulations of the partition function and approaches to quantum gravity*. Seminar for Hans Briegel's group retreat. Maria Waldrast, Austria. Sep 28, 2010.

5. *Unifying classical spin models using a quantum formalism*. Seminar for Bill Unruh's Gravity group at the University of British Columbia, Vancouver, Canada. Jul 19, 2010.

4. *Unifying all classical spin models in a lattice gauge theory*. Seminar for Ignacio Cirac's group at the MPQ, Garching, Germany. Aug 25, 2009.

3. *Unifying all classical spin models in a lattice gauge theory*. Seminar at the Institute for Theoretical Physics of the UIBK. Feb 4, 2009.

2. *Completeness of classical spin models and universal quantum computation*. Seminar for Miguel Angel Martin–Delgado's group at the Complutense University of Madrid. Jul 31, 2008.

1. *Magnetic separation of nanoparticles*. IQOQI Innsbruck, Austria. Mar 10, 2007.

Additionally presented 14 posters in conferences or workshops and attended 14 other conferences.

### Long research visits

- Perimeter Institute for Theoretical Physics, Waterloo, Canada. Feb 12 to 25, 2017 (Emmy Noether Visiting Fellow).
- Kavli Institute for Theoretical Physics (KITP), Santa Barbara, USA. Oct 17 to 28, 2016.
- Perimeter Institute for Theoretical Physics, Waterloo, Canada. Sep 5 to 30, 2016 (Emmy Noether Visiting Fellow).

Additionally made 45 research visits.

## Science communication

### Outreach articles

O1. Paradojas inalcanzables: un recorrido de la lógica a la poesía
Gemma De les Coves
The Conversation (Oct 5, 2026).

O2. ¿Qué es el arte?
Gemma De les Coves
La Maleta de Portbou, Nr. 61 (2023).

O3. La magia matemática que se esconde en la Sagrada Familia
Gemma De las Cuevas
El Pais, May 4, 2022.

O4. What is reality?
Gemma De las Cuevas
Conscious(ness) Realist, Blog by Larissa Albantakis, Apr 7, 2022.

O5. ¿Qué es la realidad?
Gemma De las Cuevas
La Maleta de Portbou Nr. 51 (2022).

O6. Magic Squares: A children's puzzle meets quantum physics
Gemma De las Cuevas, Tom Drescher and Tim Netzer
The Science Breaker (2022).

O7. Universalität und Unentscheidbarkeit gehen Hand in Hand[1]
Gemma De las Cuevas, Sebastian Stengele and Tobias Reinhart
Der Standard, Oct 27, 2021.

O8. Universality Everywhere implies Undecidability Everywhere
Gemma De las Cuevas
Undecidability, Uncomputability, and Unpredictability Essay Contest, organized by FQXi (2020).

O9. La unificación de los modelos de espín
Gemma De las Cuevas
Investigación y Ciencia N. 482, Nov 2016. (This journal no longer exists).

## PUBLIC TALKS

1. Presentation of the book-catalog *La invenció del temps*. Centre Martorell d'Exposicions, Museu de Ciències Naturals de Barcelona. With Cristina Sáez, Ricard Solé, Carles Lalueza-Fox and Arcadi Navarro. Jun 11, 2026.

2. *Física y filosofía del tiempo*. Círculo de Bellas Artes. With Carlos Sabín and Valerio Rocco. Madrid. May 20, 2026.

3. *De la intuïció a la física sobre el temps*. Biblioteca Poblenou – Manuel Arranz, Barcelona. Hosted by Prof. Francis García Collado. 20th Philosophy Series of the Biblioteques de Barcelona. Jan 13, 2026.

4. *Meravelles quàntiques i quotidianes*. Dialogue with Eloi Planes, organized by Change2Grow. Hotel Sir Victor, Barcelona. Nov 26, 2025.

5. *Quantum physics and philosophy: interferences, superpositions, entanglements*. Round table with Hans Briegel, Alyssa Ney and Michele Catanzaro. City and Science Biennale, El Born Centre Cultural, Barcelona. Nov 22, 2025.

6. Quàntica - Una ciència més estranya del que pots imaginar. Dialogue with Reis Juan. Octubre Centre de Cultura Contemporània, València. Nov 19, 2025.

7. *Opening of the 30th Science Week (Setmana de la Ciència) at the Parliament of Catalonia.* Round table with Alba Cervera Lierta and Sònia Fernàndez-Vidal. Barcelona. Nov 7, 2025.

[1] Universality and undecidability go hand in hand.

8. *Meravelles quàntiques i quotidianes*. Dialogue with Eloi Planes. Demo Day of the Fundació Catalunya Cultura. Barcelona. Jul 8, 2025.
9. *El principi de l'infinit*. Lecture at an event of the Packaging Cluster. Golf Empordà, Catalonia. Jun 20, 2025.
10. XIII Fòrum FemCAT: Quina Catalunya projectem pel 2044? Panel on Innovation and Entrepreneurship, with Àngels Fitó, Ramon Pastor and Israel Ruiz. Petit Palau de la Música, Barcelona. Nov 12, 2024.
11. Dialogue with Prof. Anna Sanpera (ICREA & UAB), Barcelona Alumni Global Summit, organized by SciTech DiploHub. Barcelona Supercomputing Center, Barcelona. Dec 27, 2019.

## Other activities

12. Our group participated in the Tag der Physik (2024, 2023 and 2022) and the Lange Nacht der Forschung (2022) with a stand entitled *Haben alle schweren Probleme eine effiziente Lösung? A million dollar question!*
13. Member of Think MINT – Mädchen wollen wissen!
14. Young Science Botschafterin of the Young Science Zentrum, Austria.

## Interviews and press coverage

1. *"Som al principi de l'infinit, però a mi em dona esperança i il·lusió"*. Interview by Joan Burdeus in the newspaper Ara. Oct 7, 2026.
2. *El principi de l'infinit*. Opinion column by Joan Borja in Alicante Plaza about my interview on À Punt Ràdio. Nov 22, 2025.
3. *Explorant la quàntica amb Gemma de les Coves*. Radio interview by Reis Juan on À Punt Ràdio, program L'hora de la cultura. Nov 18, 2025.
4. *El naixement de la teoria que va canviar el món*. Article by Toni Pou in the newspaper Ara on the centenary of quantum mechanics and the Helgoland 2025 conference, with statements by me. Aug 22, 2025.
5. *El Demo Day de l'emprenedoria cultural*. Article by Bernat Puigtobella in Núvol about my dialogue with Eloi Planes at the Demo Day of the Fundació Catalunya Cultura. Jul 9, 2025.
6. *Cremalleres de la realitat. Física, filosofia i poesia*. Podcast interview by Eli Tremps in She has a voice (episode 3x28, in Catalan). May 15, 2025.
7. *Die Grenzen der Erkenntnis* (online: *Kann die Philosophie der Physik aus der Patsche helfen?*). Article by Tanja Traxler in the Austrian newspaper Der Standard about my research. May 15, 2024.
8. *Universelle Systeme*. Article in Heureka, the science supplement of the Austrian weekly Falter, about my research. Oct 2020.
9. *Universelle Systeme: Warum ist alles so kompliziert?*. Article by Alois Pumhösel in the Austrian newspaper Der Standard about my research. Aug 17, 2020.
10. *The surprising simplicity of complexity*. Interview by Alois Pumhösel in Scilog, the science magazine of the Austrian Science Fund (FWF), on the occasion of the START Prize. Jun 19, 2020.
11. *Digging Into the Delightfully Strange*. Interview by Rose Simone in Inside the Perimeter, the magazine of the Perimeter Institute for Theoretical Physics, as Emmy Noether Visiting Fellow. 2016.

# Training and service

## Supervision

All completed theses achieved the best grade (1.0).

- PhD Theses:
  - Alexander Pappas (2026 – Present, UPF).
  - Tobias Reinhart (2021 – 2025, UIBK). *Universality in physics, computer science and beyond*.
  - Andreas Klingler (2020 – 2024, UIBK). *Tensor approximations with invariance, positivity and approximations*. PhD Prize of the Hypo Tyrol Bank 2025.
  - Mirte van der Eyden (2020 – 2024, UIBK). *Where convex cones meet tensor products: a dimension free perspective*.
- Master Theses:
  - Benjamin Engel (2022 – 2024).
  - Inga Valentiner-Branth (2020 – 2022, de facto co-supervised with Tim Netzer).
  - Joshua Graf (2019 – 2021, de facto co-supervised with Tim Netzer).
  - Anna Lina Vandré (2019 – 2020, de facto supervised by Marcelo Terra Cunha).
  - David Drexel (2019 – 2020).
  - Andreas Klingler (2019 – 2020, de facto co-supervised with Tim Netzer).
  - Matt Hoogsteder Riera (2018 – 2020, de facto co-supervised with Tim Netzer).
  - Maria Balanzó-Juandó (2017 – 2018).

## Teaching

2023 Zertifikat Lehrkompetenz (Certificate of Teaching Competence) at the University of Innsbruck.
Thesis: *Beyond praise or rebuke: Teaching encouragement — An Adlerian philosophy for teaching*

Lectures held at Universitat Pompeu Fabra:

- Calculus I (Seminars), 1st trimester 2025/26 (in Catalan and English).
- Theory of Information and Codification (Lecture+Seminars), 3rd trimester 2023/24 and 2024/25 (in Catalan and English).
- Theory of Computation (Lecture+Seminars), 1st trimester 2024/25 (in English).

Lectures held at University of Innsbruck:

- Mathematics and Computation (Lecture), Winter term 2022/23 (in English).
- Paradoxes (Lecture), Summer term 2022 (in English).
- Computational complexity for physicists (Lecture), Winter term 2020/21 and 2021/22 (in English).
- Mathematical Methods for Physicists for future teachers (Lecture), Summer term 2020 (in German).

- Mathematical Methods I (Exercises), Summer term 2019 and 2021 (in German).
- Theoretical Quantum Information (Lecture+Exercises), Winter term 2018/19 and 2019/20 (in English).
- Theoretical Physics II – Quantum Physics (Exercises), Summer term 2009 (in German).
- Theoretical Physics I – Classical Mechanics (Exercises), Winter term 2008/09 and 2010/11 (in German).

## SERVICE

- Program Committees
  - SemSpace'21 Program Committee member, held online, Jun 9 to 12, 2021.
  - TQC'20 Program Committee member, held online from Riga, Jun 9 to 12, 2020.
  - QIP'15 Program Committee member, held in Sydney, Jan 12 to 16, 2015.
  - Quantum Computation, Quantum Information and the Exact Sciences Program Committee member, held in Munich, Jan 30 to 31, 2015.
- Organization
  - Analytical and Combinatorial Methods in Quantum Information Theory II, Edinburgh, organized with Hamza Fawzi, Ivan Todorov and Andreas Winter. Jul 24 to 28, 2023.
  - Què és l'art? Palau Macaya, Barcelona, organized with Josep Ramoneda. Jun 14 to 15, 2023.
  - Measurement-Based Quantum Computation, Learning and Agency, conference in honor of Hans Briegel's 60th birthday, Obergurgl, Austrian Alps, organized with Vedran Dunjko, Wolfgang Dür and Robert Raussendorf. Aug 29 to Sep 2, 2022.
  - Random Tensors and Related Topics, CIRM Marseille, organized with Stephan Dartois, Cécilia Lancien, Luca Lionni and Ion Nechita. Mar 14 to 18, 2022.
  - Joint group retreat of the Algebra Group and our group in Maria Waldrast. Feb 20 to 22, 2020.
  - MPQ Theory Workshop 2014 in Passau, Germany. Nov 26 to 29, 2014. And MPQ Theory Workshop 2013 in Kitzbühel, Austria. Dec 11 to 14, 2013.
- Member of 13 Master Thesis committees, 1 PhD Thesis committee, 2 Habilitation committees and 1 Hiring committee at the University of Innsbruck.
- Referee for Quantum, Physical Review X, Physical Review A, Journal of Statistical Physics, New Journal of Physics, Scientific Reports, Journal of Physics A, Quantum Information Processing.

*Last update: October 30, 2026*