Lídia del Rio

lidia@phys.ethz.ch

PERSONAL DATA	Born in February 1986, in Portugal. Portuguese citizenship. Single, one child.
	ORCID: 0000-0002-2445-2701. Google Scholar profile Personal website

EMPLOYMENT

ETH Zurich, Switzerland (Renato Renner's group)

Senior scientist and lecturer, Department of Physics, August 2017–present.

Postdoctoral research assistant, Department of Physics, October 2016–July 2017.

University of Bristol, United Kingdom (Sandu Popescu's group)

Postdoctoral research assistant, School of Physics, October 2014–September 2016.

ETH Zurich, Switzerland (Renato Renner's group)

PhD student and teaching assistant, Department of Physics, August 2009–September 2014.

INSTITUTIONAL ROLES

Co-founder and president of the executive board of Quantum, a community-based, non-profit, open journal for quantum science (March 2016–present).

Co-founder and president of Squids, a non-profit organisation for knowledge transfer in quantum science and technology (November 2018–present).

Maintenance and academic support for the quantum software suite ProjectQ (March 2020–present).

Lecturer of graduate courses at ETH Zurich (February 2018–present).

Dance teacher at Cuartito Azul Tango (2014–2018 assistant, 2019–present teacher).

COST Network Thermodynamics in the Quantum regime: member of the management committee (January 2013–December 2017); contributed substantially to the original proposal (September 2012).

At University of Aveiro: spokesperson for all university students for pedagogical matters (September 2007–August 2008); spokesperson for the Physics' students (September 2006–August 2008).

EDUCATION

ETH Zurich, Switzerland

PhD (Dr. sc. ETH Zurich), Department of Physics, 17th June 2015.

- Thesis: *Resource theories of knowledge.*
- Supervisor: Renato Renner. Co-examiners: Fernando Brandão and Patrick Hayden.

Universidade de Aveiro, Portugal

Masters degree, Physics, July 2009.

- Thesis: *Thermalisation and entropy in Heisenberg spin chains.*
- Thesis supervisors: Renato Renner (ETH Zurich) and Ricardo Dias (U. Aveiro).

Licenciatura (4-year degree, pre-Bologna), Physics, July 2008.

- Thesis: *The Kondo effect in graphene.*
- Thesis supervisor: Ricardo Dias (U. Aveiro).

CAREER BREAKS

- Maternity leave: October 2019 – January 2020, and (due to the Covid19 lockdown) March – April 2020.
- Reduced workload after maternity break: 60% February–May 2020, 80% June–September 2020.
- Medical leave: January – February 2018, and October 2021 – January 2022.

MEMBERSHIPS	**Programme committees**

Programme committees
- Quantum Information Processing 2022, California Institute of Technology, USA (March 2022).
- Quantum Information Processing 2019, University of Colorado Boulder, USA (January 2019).
- Fifth Quantum Thermodynamics Conference, Oxford, UK (March 2017).
- TQC — 12th Conference on the Theory of Quantum Computation, Communication and Cryptography, Paris, France (June 2017).
- Quantum physics and logic, Nijmegen, The Netherlands (July 2017).
- AQIS — 17th Asian Quantum Information Science Conference, Singapore (September 2017).

Scientific societies

FQXi (September 2016–present), Scientific Advisory Board member since 2021.

Perimeter Institute for Theoretical Physics, visiting fellow (starting September 2022).

TEACHING
- Lecturer of the graduate course **Advanced Topics in Quantum Information Theory** (FS 2021 and FS 2022), with around 50 students, at ETH Zurich.
- Lecturer of the graduate course **Quantum Physics for Non-Physicists** (HS 2020 and HS 2022), with around 100 students, at ETH Zurich.
- Lecturer of the graduate course **Quantum Information Processing I - Concepts** (FS 2018, FS 2019), with around 150 students, at ETH Zurich.
- Tutorial on **Quantum Information Theory** at the QSIT Arosa winter school (February 2019).
- Tutorial on **Quantum information and thermodynamics**, Quantum Information Processing 2017, Seattle, US (January 2017).
- Seminar on **Introduction to resource theories** for the Quantum Engineering Centre for Doctoral Training of the University of Bristol (June 2016).
- Teaching assistant for the courses of Quantum Mechanics I and II, Quantum Information Theory, Quantum Science for Information Technology, and Statistical Physics, (September 2009–August 2013).
- Replacement lectures for Quantum Mechanics II and Quantum Information Theory (March–May 2013).

EVENT
ORGANIZATION
- Together with Nuriya Nurgalieva: Solstice of foundations 2022: summer school in quantum foundations, Zurich, Switzerland (upcoming, June 2022).
- Together with Nuriya Nurgalieva: Quantum thermodynamics, summer school, Les Diablerets, Switzerland (August 2021).
- Together with Nuriya Nurgalieva: QuID 2019 — Quantum Information for developers, summer school and hackathon, Zurich, Switzerland (September 2019).
- Together with Renato Renner and Anton Alexeev: SwissMap Workshop — Mathematical Physics meets Quantum Information, Leysin, Switzerland (June 2019).
- Together with Nuriya Nurgalieva: Solstice of foundations 2019: summer school in quantum foundations, Zurich, Switzerland (June 2019).
- QuID — Quantum Information for developers, summer school and hackathon, Zurich, Switzerland (September 2018).
- Together with Ana Belén Sainz and Matthew Fairbairn Pusey: Observers in quantum and foil theories, Perimeter Institute, Canada (April 2018).
- Solstice of foundations: summer school in quantum foundations and workshop on contextuality, Zurich, Switzerland (June 2017).
- Workshop on quantum information and foundations of thermodynamics, Zurich, Switzerland (August 2011).

GRANTS AND
AWARDS
- FQXi large grant Consciousness in the Physical World, for the project Conditions for sentience in physical theories (October 2020 – September 2022).
- Grant for post-doctoral mothers at the Physics Department of ETH Zurich, to fund a PhD student (Nuriya Nurgalieva) in the first year after maternity leave (February 2020 – January 2021).
- Qstarter technology transfer award 2018, by QSIT, the Swiss National Centre of Competence in Research for Quantum Science and Technology, its industry partners, and a representative of the Swiss National Science Foundation, for Quantum Journal (February 2018).
- FQXi minigrant Physics of the Observer, for support for conference Q-TURN 2018 (December 2017).

- FQXi minigrant Physics of the Observer, for support for the summer school on quantum foundations 2017 (December 2016).
- FQXi large grant Physics of the Observer, for the project Many worlds, many times: Emergent observers in non-probabilisitic theories (September 2016–August 2017).
- PhD scholarship from the Portuguese Foundation for Science and Technology (August 2009–July 2013).
- Physics department award of University of Aveiro (best Physics undergrad), July 2007.
- Merit award of University of Aveiro (awarded to the best students in science degrees), July 2006 and July 2007.
- Best first-year student in a science degree at University of Aveiro, 2006.
- Best first-year award at University of Aveiro (for the best applying mark to Physics), July 2005 (kept the award in July 2006 and July 2007).
- High school: National winner of the Environment Olympiads in May 1999, runner-up in May 2000 and May 2003.

PUBLICATION
LIST

Florian Meier and Lídia del Rio,
Thermodynamic optimization of quantum algorithms: on-the-go erasure of qubit registers,
arXiv:2112.04402 (2021).

Lorenzo Laneve and Lídia del Rio,
Impossibility of composable Oblivious Transfer in relativistic quantum cryptography,
arXiv:2106.11200 (2021).

Ladina Hausmann, Nuriya Nurgalieva and Lídia del Rio,
A consolidating review of Spekkens' toy theory,
arXiv:2105.03277 (2021).

Lea Krämer and Lídia del Rio,
Currencies in resource theories,
Entropy, vol. 23, no. 6, pp. 755 (2021).

Patrick Fraser, Nuriya Nurgalieva, Lídia del Rio,
Fitch's knowability axioms are incompatible with quantum theory, arXiv:2009.00321 (2020).

Carlo Sparaciari, Lídia del Rio, Carlo Maria Scandolo, Philippe Faist, Jonathan Oppenheim,
The first law of general quantum resource theories,
Quantum 4, 259 (2020).

Raban Iten, Tony Metger, Henrik Wilming, Lídia del Rio and Renato Renner,
Discovering physical concepts with neural networks,
Phys. Rev. Lett. 124, 010508 (2020).

Matthew F. Pusey, Lídia del Rio, Bettina Meyer,
Contextuality without access to a tomographically complete set,
arXiv:1904.08699 (2019).

V. Vilasini, Nuriya Nurgalieva, Lídia del Rio,
Multi-agent paradoxes beyond quantum theory,
New J. Phys. 21, 113028 (2019).

Nuriya Nurgalieva and Lídia del Rio,
Inadequacy of modal logic in quantum settings,
Proceedings of QPL 2018, EPTCS 287, pp. 267-297 (2019).

V. Vilasini, Christopher Portmann and Lídia del Rio,
Composable security in relativistic quantum cryptography,
New J. Phys. 21, 043057 (2019).

Lea Krämer and Lídia del Rio,
Operational locality in global theories,
Phil. Trans. R. Soc. A 2018 376 20170321 (2018).

Lídia del Rio, Adrian Hutter, Renato Renner and Stephanie Wehner,
Relative thermalization,
Phys. Rev. E 94, 022104 (2016).

John Goold, Marcus Huber, Arnau Riera, Lídia del Rio and Paul Skrzypczyk,
The role of quantum information in thermodynamics — a topical review
Journal of Physics A 49, 19 (2016).

Lídia del Rio, Lea Krämer and Renato Renner,
Resource theories of knowledge,
arXiv:1511.08818 (2015).

Lídia del Rio, Johan Åberg, Renato Renner, Oscar Dahlsten and Vlatko Vedral,
The thermodynamic meaning of negative entropy,
Nature 474, 61–63 (2011).

SUPERVISION
OF JUNIOR
RESEARCHERS

Supervised 23 masters and semester projects:
- Marc Sans Drudis, *Logic paradoxes and weak measurements in the present of noise*, semester project (ongoing).
- Janek Denzler, *Self-testing from operational proofs of contextuality*, masters thesis (May 2021).
- Florian Meier, *Online erasure in quantum algorithms: the hidden subgroup problem*, semester project (April 2021).
- Ladina Hausmann, *Axiomatic approach to black hole thermodynamics*, masters thesis (March 2021, co-supervised with Nuriya Nurgalieva).
- Oliver Knapp, *Quantum reference frames in spin chains*, semester project, (December 2020, co-supervised with Nuriya Nurgalieva).
- Ladina Hausmann, *On multi-agent logical paradoxes in epistemically-restricted hidden variable theories*, semester project (June 2020, co-supervised with Nuriya Nurgalieva).
- Simon Matthis, *Simulation of quantum agents on a quantum computer*, extra-curricular project (August 2020, co-supervised with Nuriya Nurgalieva).
- Anne-Catherine de la Hamette, *Quantum reference frames from quantum communication*, semester project (January 2020, co-supervised with Nuriya Nurgalieva).
- Romain Moyard *Lagrangian Quantum Mechanics*, semester project (November 2019, co-supervised with Nuriya Nurgalieva).
- Giulia Mazzola, *The equivalence principle in quantum settings*, semester project (March 2019).
- Laura Burri, *Quantum space-time and reference frames*, bachelors project (June 2018).
- Dmitry Grinko, *Collapse theories*, semester project (April 2018).
- Shishir Khandelwal, *Thermodynamics with accelerated observers*, semester project (May 2018).
- Nuriya Nurgalieva, *Logic of agents in quantum settings*, masters thesis (July 2018).
- Nuriya Nurgalieva, *Quantum reference frames for experiments where observers can be measured*, semester project (September 2017).
- V. Visalini, *Quantum causal structures*, masters thesis (July 2017).
- Martin Lieckteig, *Modeling explicit knowledge for noisy and thermal operations*, masters thesis (January 2017, co-supervised with Lea Krämer).
- Tom Farshi, *Operational notions of temperature in quantum thermodynamics*, masters thesis (June 2016, University of Bristol).
- Philipp Kammerlander, *Self-contained work extraction — model of a semi-quantum Szilard engine*, masters thesis (September 2013).
- Bettina Meyer, *Work extraction from pure qubits in ion traps*, masters thesis (March 2013).
- Philipp Kammerlander, *Work extraction from pure qubits*, semester project (May 2012).
- Raphaël Christophe, *Purity compression*, masters thesis (March 2012).
- Adrian Hutter, *The foundations of statistical physics from first principles of quantum mechanics: deriving equipartition from the decoupling approach*, semester project (January 2011).

Carlo Sparaciari, **Lídia del Rio**, Carlo Maria Scandolo, Philippe Faist, Jonathan Oppenheim,
The first law of general quantum resource theories, Quantum 4, 259 (April 2020).

We extend the tools of quantum resource theories to scenarios in which multiple quantities (or resources) are present, and their interplay governs the evolution of physical systems. We derive conditions for the interconversion of these resources, generalising the first law of thermodynamics. Additionally, generalisations of the Helmholtz free energy, and of adiabatic and isothermal transformations, emerge: we find a set of laws for quantum multi-resource theories, which generalise the laws of thermodynamics.

V. Vilasini, Christopher Portmann and **Lídia del Rio**,
Composable security in relativistic quantum cryptography, New J. Phys. 21, 043057 (April 2019).

Relativistic protocols have been proposed to overcome certain impossibility results in classical and quantum cryptography. In such a setting, one takes the location of honest players into account, and uses the signalling limit given by the speed of light to constraint the abilities of dishonest agents. However, composing such protocols with each other to construct new cryptographic resources is known to be insecure in some cases. To make general statements about such constructions, a composable framework for modelling cryptographic security in Minkowski space is required. Here, we introduce a framework for performing such a modular security analysis of classical, quantum and post-quantum cryptographic schemes in Minkowski space. As an application, we show in particular the non-composability of any relativistic bit commitment and coin flipping protocols.

ACADEMIC REFEREES

Sandu Popescu, University of Bristol, S.Popescu@bristol.ac.uk

Renato Renner, ETH Zurich, renner@phys.ethz.ch

Robert Spekkens, Perimeter Institute for Theoretical Physics, rspekkens@perimeterinstitute.ca