Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

Rodrigo Arouca

Postdoc

Personal Information

- Full Name: Rodrigo Arouca de Albuquerque
- Birth: 29/03/1993, Fortaleza, Brazil
- Nationality: Brazilian and Portuguese.
- Single
- Contact information:
  Institutional e-mail rodrigo.arouca@physics.uu.se
  Personal e-mail raroucaa@gmail.com
  Mobile number +46723730409 (SE), +5521994696376 (BR)
  Skype name raroucadealbuquerque

Employment and Scholarships

2021-Present, *Postdctoral Researcher*, Quantum Matter Theory group, Uppsala University
I am currently a postdoc in the group of Prof. Annica Black-Schaffer with a scholarship founded by the Knut and Alice Wallenberg foundation.

2020-2021, *Super teaching assistant*, Institute for Theoretical Physics (ITP), Utrecht University (Utrecht University)
Super teaching assistant at the course Quantum Field Theory, ITP, Utrecht University.

2018-2021, *Visiting PhD student*, ITP, Utrecht University
I was several times a visiting PhD student at Prof. Cristiane Morais Smith's group. The total time that I spent in the group was 21 months.

2017-2021, *PhD candidate*, Physics Institute, Federal University of Rio de Janeiro (IF-UFRJ)

2015-2017, *MsC candidate*, IF-UFRJ

2011-2014, *Scientific initiation student*, IF-UFRJ
I received a scholarship from the Brazilian National Scientific Initiation Program that aims at bolstering research among bachelor students. I was supervised by Prof. Luca Moriconi and studied turbulence using statistical physics and quantum field theory methods.

2008-2010, *Full scholarship at my high school*
I received a full scholarship at my (private) high school as I was one of the best students in my class.

Education

2017 - 2021 , with 21 months exchange at Utrecht University
PhD in Physics. Supervisor: Eduardo Cantera Marino, Co-supervisor: Cristiane Morais Smith
Thesis: *Quantum phase transitions in topological systems and in High-Tc cuprates*

2015-2017, UFRJ
MsC in Physics, UFRJ
Supervisor: Mohammed ElMassalami

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

Thesis: *Normal and superconducting state phase diagram of layered BiS_2-based compounds*

2011-2014, UFRJ
Bachelor in Physics.

Honors and Awards

2020-2021, *super teaching assistant*, ITP, Utrecht University
The super teaching assistant is a position appointed by the Director of Education of the Physics Department of Utrecht University. The person selected for this position should have an extensive teaching experience and is responsible for improving the course and coordinating the other teaching assistants.

2019-2020, *CAPES PrInt exchange PhD scholarship*, ITP, Utrecht University
I was funded by the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES) for a six-months stay in the group of Prof. Cristiane Morais Smith at the ITP, Utrecht University. This scholarship aims at improving the internationalization of Brazilian universities and I was one of the two students selected in my PhD program to receive this scholarship.

2018-2019, *Delta-ITP Visiting PhD student*, NWO
I was a visiting PhD student at the ITP, Utrecht University twice for a total time of six months. This was financed by the Delta Institute for Theoretical Physics (Delta-ITP) with funding from NWO.

2017-2021 , *CNPq scholarship*
I was ranked second in the general selection for PhD students at the Physics Institute (IF) at UFRJ. Because of this ranking, I had a scholarship that also covers travel and maintenance costs funded by the National Council for Scientific and Technological Development (CNPq).

2016, *Grade 10 Student Scholarship*, FAPERJ
During my masters, I was one of the two master students selected to have a Grade 10 Student Scholarship funded by the Rio de Janeiro State Research Support Foundation (FAPERJ).

2015, *best poster*, Week of Physics, UFRJ
The poster about my master thesis project was selected as one of the best posters at the Week of Physics, a student organized School at IF-UFRJ.

2010, *honorable mention*, 2010 Physics Challenge, PUC-RJ
I received a honorable mention in the 2010 Physics Challenge organized by the Pontifical Catholic University (PUC) of Rio de Janeiro. This is an exam on advanced high school physics to select young talents in physics.

2010, *honorable mention*, National Olympiad of Brazilian History, UNICAMP
My group received a honorable mention at the second National Olympiad of Brazilian History organized by the State University of Campinas (UNICAMP).

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

2009, *bronze medal*, National Olympiad of Brazilian History, UNICAMP
My group received a bronze medal at the first National Olympiad of Brazilian History organized by the State University of Campinas (UNICAMP).

Publications

In Press

1. R Cañellas Núñez, Chen Liu, R Arouca*, L Eek, Guanyong Wang, Yin Yin, Dandan Guan, Yaoyi Li, Shiyong Wang, Hao Zheng, Canhua Liu, Jinfeng Jia*, C Morais Smith, *Topological edge and corner states in Bi fractals on InSb*, Nat. Phys. (arXiV).* corresponding author

Published

2. E. Slootman, W. Cherifi, L. Eek, R Arouca, E.J. Bergholtz, M. Bourennane, C. Morais Smith, *Breaking and resurgence of symmetry in the non-Hermitian Su-Schrieffer-Heeger model in photonic waveguides*, Phys. Rev. Research 6, 023140 (2024) (arXiV).

3. R. Arouca, J. Cayao, and A. M. Black-Schaffer, *Exceptionally enhanced topological superconductivity*, Phys. Rev. B 108, L060506 (2023) (arXiV).

4. R. Arouca, A. Cappeli, and T. H. Hansson, *QFT Anomalies in Condensed Matter Physics* (Lecture Notes), SciPost Phys. Lect. Notes 62 (2022)(arXiV).

5. R. Arouca, E. C. Marino, C. Morais Smith, *Non-Hermitian quantum gases: a platform for imaginary time crystals* , Quantum Frontiers 1, 2 (2022) (arXiV).

6. R. Arouca, C. H. Lee and C. Morais Smith, *Unconventional scaling at non-Hermitian critical points*, Physical Review B 102, 245145 (2020) (arXiV).

7. R. Arouca, S. N. Kempkes and C. Morais Smith, *Thermodynamics of a higher-order topological* insulator, Physical Review Research 2, 023097 (2020) (arXiV).

8. E. C. Marino and R. Arouca, *Magnetic field effects on the transport properties of high-Tc cuprates*, Superconductor Science and Technology 34, 085008 (2021). (arXiV).

9. R. Arouca and E. C. Marino, *The Resistivity of High-Tc Cuprates*, Superconductor Science and Technology 34 035004 (2021) (arXiV).

10. E. C. Marino, R. O. Corrêa Jr, R. Arouca, L. H. Nunes and V. S. Alves, *Superconducting and pseudogap transition temperatures in high-Tc cuprates and the Tc dependence on pressure*, Superconductor Science and Technology, 33(3), 035009 (2020) (arXiV).

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

11. R. Arouca et al, *Manifestation of hopping conductivity and granularity within phase diagrams of* $LaO_{1-x}F_xBiS_2$, $Sr_{1-x}La_xFBiS_2$ *and related* BiS_2*-based compounds*, Journal of Physics Condensed Matter 29, 355702 (2017).

Submitted

R. Arouca, T. Nag, A.M. Black-Schaffer , *Mixed higher-order topology and nodal and nodeless flat band topological phases in a superconducting multiorbital model*, submitted to Phys. Rev. B (arXiV).

In preparation

D.F. Muñoz Arboleda, R. Arouca, C. Morais Smith , *Finite temperature effects in the non-reciprocal SSH model* (provisory title).

A. K. Ghosh, R. Arouca, A. M. Black-Schaffer , *Spectral localizer for disordered Floquet system* (provisory title).

R. Arouca, W. Uijttewaal, C. Morais Smith , *Particle interacting with a two-levels system reservoir revisited: time crystalline behavior and non-Hermitian effects* (provisory title).

Research Skills and Programming Languages

Calculation of several equilibrium and out-of-equilibrium thermodynamic quantities

I employed both *exact diagonalization* and *non-pertubative methods in QFT* such as the saddle point approximation (both many body and stochastic systems) to compute thermodynamic properties of different condensed matter systems.
With these techniques, I calculated quantities such as thermodynamic potentials, resistivity, density of states, critical temperatures and probability distribution functions for stochastic systems.

Calculation of band structure and topological invariants in tight-binding models

I mastered both analytical and numerical methods to compute topological invariants. In special, I calculated Wilson loops in higher-order topological insulators and winding numbers in Hermitian and non-Hermitian topological models with chiral symmetry. I computed also entanglement spectrum and Majorana polarization to do real space characterization of topology.

Field theory methods and models in condensed matter

I am familiar with several quantum field theory methods for condensed matter and out of equilibrium systems. In special:

- Spin-fermion models
- Non-linear Sigma models
- Schwinger-Dyson equations
- QED
- Topological Field Theory
- Martin-Siggia-Rose formalism

Analysis of experimental data

My works in superconductivity are heavily focused on rationalizing large amounts of experimental data. This required organization and classification of all this data and understanding the range and parameters of the theories that explain the data.

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

Simulation of ordinary differential equations
Using Runge-Kutta and Euler methods (basic level, used in my scientific initiation research).

Classical Monte Carlo method
Using the Metropolis algorithm (basic level, used in my scientific initiation research).

Programming languages
- Python
- C/C++
- Mathematica

Supervision and Teaching

Supervision

1. 2024-Present, Leen Mys, *Master thesis* in Physics, KU Leuven, Erasmus student at Uppsala University
Provisory title: *Cooper problem close to an exceptional point.*

Co-supervision

2. 2024-Present, Minna Palmgren Thun, *Nordita summer internship student*
Provisory title: *Quasiclassical approach to superconductivity.*. Supervisor: Patric Holmvall.

3. 2022-2023, Emiel Slootman, *Master thesis* in Theoretical Physics, Utrecht University and Twente University
Title: *Spectral and Thermodynamical Properties of non-Hermitian Photon Gases*. Supervisors: Prof. Cristiane Morais Smith, Prof. Jan Klärs and Prof. Pepijn Pinkse.

4. 2021-2022, Robert Cañellas Núñez, *Master thesis* in Theoretical Physics, ITP, Utrecht University
Title: *Spin-Orbit coupling in a fractal lattice.*, supervisor: Prof. Cristiane Morais Smith.

5. 2021-2022, Maria Alice Neves, *Master thesis* in Physics, Federal University of São Del Rei
Title: *Efect of zinc as a non-magnetic impurity in high-Tc cuprates* , supervisor: Prof. Lizardo Nunes.

6. 2020-2021, Maarten Droste, *Master thesis* in Theoretical Physics (complex systems profile), ITP, Utrecht University
Title: *A functional approach to the stochastic Lotka-Volterra equations*, supervisors: Prof. Cristiane Morais Smith, Prof. Paul Zegeling.

7. 2020-2022, Wies Uijttewaal, *Master thesis* in Theoretical Physics, ITP, Utrecht University
Title: *Time Crystals in Open Quantum Systems: Dynamical Localisation of Particles Coupled to a Two-Level System Reservoir*, supervisor: Prof. Cristiane Morais Smith.

8. 2020-2020, Luuk Goode. *Bachelor thesis* in Physics, ITP, Utrecht University
Title: *Superconductivity with a twist*, supervisor: Prof. Cristiane Morais Smith.

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

9. 2019-2020, Marina Moesia, *Scientific initiation* in Physics, IF-UFRJ
Research topic: *Hydrodynamic description of hurricanes using vortices*. Supervisor: Prof. Luca Moriconi. She shared the best presentation award for her session in the annual Scientific Initiation Meeting of UFRJ.

Teaching

1. 2023, *Lecturer*, *QFT Anomalies in Condensed Matter Physics*, Nordita
PhD course hosted by Nordita with students from Uppsala University, Stockholm University, and the Royal Institute of Technology (KTH). I was a lecturer in the course together with Prof. Thors Hans Hansson.

2. 2020-2021, *Super teaching assistant*, *Quantum Field Theory*, ITP, Utrecht University
Master level course. Lecturer: Prof. Umut Gursoy. I supervised exercise tutorial sessions for roughly one third of the class (approximately 30 students), corrected some of the exercises, helped in the elaboration of the lecture notes and took part in much of the organization of the online classes and environment.

2. 2020-2020, *Teaching assistant*, *QFT Anomalies in Condensed Matter Physics*, Delta-ITP
Advanced Topics in Theoretical Physics (ATTP) course held at the universities of Utrecht, Amsterdam and Leiden organized by the Delta-ITP. Lecturer: Prof. Thors Hans Hansson.

3. 2019-2019, *Teaching assistant*, *Renormalization group methods*, Delta-ITP
Advanced Topics in Theoretical Physics (ATTP) course held at the universities of Utrecht, Amsterdam and Leiden organized by the Delta-ITP. Lecturer: Prof. Lars Fritz.

4. 2019-2019, *Lecturer*, *Experimental Physics II*, UFRJ
A basic experimental course on wave mechanics for first year bachelor students in many scientific and engineering courses at UFRJ (UFRJ).

5. 2018-2018, *Teaching assistant*, *Topological Quantum Matter*, Delta-ITP
An Advanced Topics in Theoretical Physics (ATTP) course held at the universities of Utrecht, Amsterdam and Leiden organized by the Delta-ITP. Lecturer: Prof. Vladimir Juricic.

6. 2015-2016, *Lecturer*, *Experimental Physics III*, UFRJ
A basic experimental course on electrical circuits for second year bachelor students in many scientific and engineering courses at UFRJ (UFRJ).

Organization skill

2023-2024, *Organizer of the workshop Quantum Field Theory Approach to condensed matter physics*, UFRJ, Brazil.
This workshop happened between 6 and 8 of May and celebrated the 70 years of Prof. Eduardo Marino with speakers from Brazil, Sweden, and the Netherlands.

2023-Present, *Organizer of the workshop Topology and Correlations in Crystals and Quantum Matter*, Les Houches, France.
Co-organized with Mark Goerbig, Vladimir Juricic, Marco di Liberto, and Flore Kunst

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

2023-Present, *Organizer of the integration activities of the Dynamical Quantum Matter project grant*, Uppsala University.
I am co-organizing, together with Claudia Artiaco, Lukas König, Miguel Martínez, Paolo Molignini, and Tien Tien Yeh some activities to promote collaboration in the project grant dynamical quantum matter, which founds my posdoc position in the group of Prof. Annica Black-Schaffer, that is owned by Profs. Alexander Balatsky, Jens Bardarson, Emil J. Bergholtz, Annica Black-Schaffer and Stefano Bonneti. The activities consist in a seminar series held monthly and alternating between the member of the five group and yearly retreats.

2022-2023, *Quantum matter theory program seminars organizer*, materials theory division, Uppsala University.

2020-2021, *group meetings and seminars organizer*, Prof. Cristiane Morais Smith's group.

2014, *Winter School organizer*, IF-UFRJ
This event was a one week School organized for bachelor students focused on theoretical physics. I organized the event together with two other last year bachelor students.

Invited talks

2024, Solid State Seminar, UFRJ, Rio de Janeiro, Brazil
Title: *Topological edge and corner states in Bi fractals on InSb*.

2024, Physics & Topology Workshop, Sapienza University, Rome, Italy
Title: *Topological superconductivity enhanced by exceptional points*.

2022, Joint Condensed Matter Seminar series, Nordita, Sweden
Title: *Exceptionally enhanced topological superconductivity*.

2022, Wilczek Quantum Center seminar, Shangai Jiao Tong University, China
Title: *Non-Hermitian quantum gases: a platform for imaginary time crystals*.

2022, Quantum Matter group seminar, UFRJ, Brazil
Title: *Non-Hermitian quantum gases: a platform for imaginary time crystals*.

2021, Quantum Simulation & Technology Group Seminar, International Institute of Physics, Natal, Brazil
Title: *Unconventional scaling at non-Hermitian critical points*.

2020, DITP Quantum and Topological Matter meeting, Amsterdam University, the Netherlands
Title: *Thermodynamics of higher-order topological insulators*.

2017, *Coloquinho-IF-UFRJ*, IF-UFRJ, Brazil
Title: *Superconductivity: Fundamentals, applications and dilemmas*. The Coloquinho is a series of coloquia aimed at introducing research fields to bachelor students.

Contributed Talks

2024, APS March Meeting 2024, Minneapolis, USA
Title: *First- and second-order topological phases in a superconducting multiorbital model.*

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

2023, Non-Hermitian Topology Workshop, Dresden, Germany
Title: *Exceptionally enhanced topological superconductivity.*

2022, APS March Meeting 2022, Chicago, USA
Title: *Non-Hermitian quantum gases: a platform for imaginary time crystals.*

2021, Brazilian Physical Society Autumn Meeting 2021, online
Title: *Unconventional scaling at non-Hermitian critical points.*

2019, Brazilian Physical Society Autumn Meeting, Aracaju, Brazil
Title: *Thermodynamics of a quadrupolar topological insulator.*

2017, XL Brazilian Physical Society Cond. Mat. Meeting, Buzios, Brazil
Title: *Manifestation of hopping conductivity and granularity within phase diagrams of* $LaO_{1-x}F_xBiS_2$, $Sr_{1-x}La_xSr_{1x}La_xFBiS_2$ *and related* BiS_2*-based compounds*.

Posters presented in conferences

2023, Correlations in Novel Quantum Materials 2023, Max Planck Institute for Solid States Physics, Stuttgart, Germany
Title: *Exceptionally enhanced topological superconductivity*.

2022, Materials and Mechanism of Superconductivity (M^2S) 2022, Vancouver, Canada
Title: *Exceptionally enhanced topological superconductivity*.

2021, Physics at Veldhoven 2021, Veldhoven, the Netherlands
Title: *Unconventional scaling at non-Hermitian critical points*.

2020, Physics at Veldhoven 2020, Veldhoven, the Netherlands
Title: *Thermodynamics of a higher-order topological insulator*.

2019, Brazilian Physical Society Autumn Meeting, Aracaju, Brazil
Title: *Bethe-Salpeter Equations for Pseudo QED and the Spectrum of Transition Metal Dichacolgenides*.

2016, Brazilian Physical Society Physics Meeting, Natal, Brazil
Quinquennal meeting of all areas of physics in Brazil. Title: *Analysis of the resistive scattering processes and events in the* BiS_2*-based systems*.

2015, XXXVIII Brazilian Physical Society Condensed Matter Meeting, Foz do Iguaçu, Brazil
Title: *Characterization of the normal-state phase diagram of the* $LaO_{1-x}F_xBiS_2$ *system*.

Selected schools and workshops participation

2024, Fourty Years of Conformal Field Theory, Galileo Galilei Institute, Florence, Italy

2022, Quantum Connections in Sweden 2022, Lidingö, Sweden

2020, SFT 2020-Lectures on Stastical Field Theories, Galileo Galilei Institute, Florence, Italy

2019, *Brazilian School of Superconductivity: from nanosuperconductors to quantum computing*, IF, Federal University of São Carlos, Brazil

Rodrigo Arouca
Homepage
Google Scholar
Research Gate
Lattes CV

2018, Workshop on Strong Electron Correlations in Quantum Materials: Inohomogeneities, Frustration and Topology, ICTP-SAIFR, São Paulo, Brazil

2015, *VI Workshop on Theoretical Physics*, Brazilian Center for Research in Physics (CBPF), Rio de Janeiro, Brazil

Administrative and referee work

2022-present, *Referee*, Physical Review Letters

2022-present, *Referee*, Physical Review A

2022-present, *Referee*, Physical Review B

2021-present, *Referee*, New Journal of Physics

2022-present, *Referee*, Journal of Physics A: Mathematical and Theoretical

2023-present, *Referee*, Journal of Mathematical Biology

2016-2019, *Student representative*, physics graduate program, UFRJ

2018-2019, *Student referee*, distinct scholarships committees, graduate program, UFRJ

Committees

2024, *Member of comitee*, Master Defense of Daniel Crizostomo Da Costa titled *Supercondutividade em bandas planas na rede quadrada-octogonal* (in Portuguese).
Federal University of São João Del-Rei, Brazil. Student of Prof. Lizardo Nunes.

2023, *Member of comitee*, PhD Defense of Rodrigo Corso Baptista dos Santos titled *Applications of Conformal Field Theory in Topological Phases of Matter*.
State University of Londrina, Brazil. Student of Prof. Pedro Gomes.

Referees

PhD Supervisor Prof. Cristiane Morais Smith,
e-mail C.deMoraisSmith@Utrecht University.nl
PhD Supervisor Prof. Eduardo Cantera Marino
e-mail marino@if.ufrj.br
Posdoc Supervisor Prof. Annica M. Black-Schaffer,
e-mail annica.black-schaffer@physics.uu.se
Senior Collaborator Prof. Thors Hans Hansson,
e-mail hansson@fysik.su.se
Senior Collaborator Prof. Emil J. Bergholtz,
e-mail emil.bergholtz@fysik.su.se