Rubén Seoane Souto

PERSONAL INFORMATION

Professorsgatan
Lund, Sweden 22100
Website: https://rubenseoanes.github.io/
ORCID: 0000-0002-2978-3534

+46 46 222 3171
ruben.seoane_souto@ftf.lth.se
Researcher ID: N-8483-2016

ACADEMIC POSITIONS

Marie Curie research fellow 1/2023 to present
Department of theoretical condensed matter physics,
Universidad Autónoma de Madrid

Postdoctoral researcher 11/2022 to 12/2022
Center for Quantum Devices, Niels Bohr Institute
University of Copenhagen

Researcher 11/2020 to 10/2022
Solid state division and Nanolund, Lund university,
Visiting researcher at Center for Quantum Devices
University of Copenhagen

Posdoctoral researcher 11/2018 to 10/2020
Solid state division and Nanolund, Lund university,
Visiting researcher at Center for Quantum Devices
University of Copenhagen

Adjunct professor (during the Ph.D. studies) 10/2016-10/2018
Department of theoretical condensed matter physics,
Universidad Autónoma de Madrid

Doctoral student 1/2013-10/2016
Department of theoretical condensed matter physics,
Condensed matter Physics center (IFIMAC)
Universidad Autónoma de Madrid
Supervisors: Prof. Alfredo Levy Yeyati and Prof. Álvaro Martín-Rodero

RESEARCH VISITS

Laboratoire Ondes et Matiere d'Aquitaine, CNRS 4/2016-7/2016
Université de Bordeaux
Supervisor: Dr. Rémi Avriller

EDUCATION

Universidad Autónoma de Madrid, Madrid, Spain

Ph.D., Condensed matter physics, nanophysics and biophysics, 15/6/2018

Thesis title: *Quench dynamics in interacting and superconducting nanojunctions.*
Supervisors: Prof. Alfredo Levy Yeyati and Prof. Álvaro Martín Rodero

Master's degree, Master in condensed matter physics and nanotechnology, 7/2013

Master thesis: *Electronic transport through molecular transistors in the polaronic regime*
Supervisors: Prof. Alfredo Levy Yeyati, Prof. Álvaro Martín Rodero and Prof. Rosa C. Monreal

Universidad Complutense de Madrid, Madrid, Spain

Extended Bachelor in Physics (5 years degree), 7/2012

- Undergraduate thesis: *Strong coupling correlation functions and semiclassical strings*
- Supervisor: Rafael Hernández Redondo, Ph.D.
- Topic: String theory

RESEARCH INTERESTS

- Quantum transport
- Topological states of matter
- Mesoscopic superconductivity
- Quantum technologies

REFEREED JOURNAL PUBLICATIONS

1. D. Razmadze*, **R. Seoane Souto***, L. Galletti, A. Maiani, Y. Liu, P. Krogstrup, C. Schrade, A. Gyenis, C. M. Marcus, and S. Vaitiekėnas, "Supercurrent reversal in ferromagnetic hybrid nanowire Josephson junctions" Phys. Rev. B **107**, L081301 (2023). (*Equal author contribution)
2. **R. Seoane Souto**, M. Leijnse, and C. Schrade, "The Josephson diode effect in supercurrent interferometers" Phys. Rev. Lett. **129**, 267702 (2022).
3. **R. Seoane Souto**, M. M. Wauters, K. Flensberg, M. Leijnse, and M. Burrello, "Multiterminal transport spectroscopy of subgap states in Coulomb-blockaded superconductors' Phys. Rev. B **106**, 235425 (2022).
4. A. Tsintzis, **R. Seoane Souto**, and M. Leijnse, "Creating and detecting poor man's Majorana bound states in interacting quantum dots" Phys. Rev. B **106**, L201404 (2022)
5. M. Nitsch, **R. Seoane Souto**, and M. Leijnse, "Interference and parity blockade in transport through a Majorana box" Phys. Rev. B **106**, L201305 (2022)
6. S. D. Escribano, A. Maiani, M. Leijnse, K. Flensberg, Y. Oreg, A. Levy Yeyati, E. Prada, and **R. Seoane Souto**, "Semiconductor-ferromagnet-superconductor planar heterostructures for 1D topological superconductivity" NPJ Quantum Mater. **7**, 81 (2022)
7. **R. Seoane Souto** and M. Leijnse, "Fusion rules in a Majorana single-charge transistor" SciPost Phys. **12**, 161 (2022)
8. S. Krøjer, **R. Seoane Souto**, and K. Flensberg, "Demonstrating Majorana nonabelian exchange using fast adiabatic charge-transfer" Phys. Rev. B **105**, 045425 (2022)
9. S. Vaitiekėnas, **R. Seoane Souto**, Y. Liu, P. Krogstrup, K. Flensberg, M. Leijnse, C. M. Marcus, "Evidence for spin-polarized bound states in semiconductor – superconductor – ferromagnetic-insulator islands" Phys. Rev. B **105**, L041304 (2022)
10. **R. Seoane Souto** A. E. Feiguin, A. Martín-Rodero, and A. Levy Yeyati, "Transient dynamics of a magnetic impurity coupled to superconducting electrodes: exact numerics versus perturbation theory" Phys. Rev. B **104**, 214506 (2021)
11. D. Kuzmanovski , **R. Seoane Souto**, and A. V. Balatsky "Persistent current noise in narrow Josephson junctions"Phys. Rev. B **104**, L100505 (2021)
12. A. Maiani, **R. Seoane Souto**, M. Leijnse, and K. Flensberg "Topological superconductivity in semiconductor-superconductor-magnetic insulator heterostructures"Phys. Rev. B **103**, 104508 (2021)
13. **R. Seoane Souto**, D. Kuzmanovski, and A. V. Balatsky, "Signatures of odd-frequency pairing in the Josephson junction current noise"Phys. Rev. Research **2**, 043193 (2020)
14. D. Kuzmanovski, **R. Seoane Souto**, and A. V. Balatsky, "Odd-frequency superconductivity near a magnetic impurity in a conventional superconductor"Phys. Rev. B **101**, 094505 (2020)
15. **R. Seoane Souto**, K. Flensberg, and M. Leijnse,"Timescales for charge transfer based operations on Majorana systems" Phys. Rev. B **101**, 081407 (Rapid communication) (2020)
16. R. Avriller, **R. Seoane Souto**, A. Martín-Rodero, and A. Levy Yeyati, "Build-up of Vibron-Mediated Electron Correlations in Molecular Junctions". Phys. Rev. B **99**, 121403 (Rapid communication) (2019)

17. **R. Seoane Souto**, R. Avriller, A. Levy Yeyati, and A. Martín-Rodero, "Transient dynamics in interacting nanojunctions within self-consistent perturbation theory" New J. Phys. **20**, 083039 (2018)

18. **R. Seoane Souto**, A. Martín-Rodero, and A. Levy Yeyati, "Quench dynamics in superconducting nanojunctions: Metastability and dynamical Yang-Lee zeros". Phys. Rev. B **96**, 165444 (2017)

19. **R. Seoane Souto**, A. Martín-Rodero, and A. Levy Yeyati, "Analysis of universality in transient dynamics of coherent electronic transport". Fortschr. Phys. **65**, 1600062 (2017)

20. **R. Seoane Souto**, A. Martín-Rodero, and A. Levy Yeyati, "Andreev Bound States Formation and Quasiparticle Trapping in Quench Dynamics Revealed by Time-Dependent Counting Statistics". Phys. Rev. Lett. **117**, 267701 (2016)

21. **R. Seoane Souto**, R. Avriller, R. C. Monreal, A. Martín-Rodero, and A. Levy Yeyati, "Transient dynamics and waiting time distribution of molecular junctions in the polaronic regime". Phys. Rev. B **92**, 125435 (2015)

22. **R. Seoane Souto**, A. Levy Yeyati, A. Martín-Rodero, R. C. Monreal, "Dressed tunneling approximation for electronic transport through molecular transistors". Phys. Rev. B **89**, 085412 (2014)

PREPRINTS

1. A. Maiani, K. Flensberg, M. Leijnse, C. Schrade, S. Vaitiekėnas, and R. Seoane Souto "Nonsinusoidal current-phase relations in semiconductor-superconductor-ferromagnetic insulator devices" arXiv:2302.04267.

REFEREE ACTIVITIES

Regular referee of journals of the American Physical Society, including Physical Review Letters, Physical Review B and Physical Review Research. Referee Springer Nature journals, including Nature Physics, Communications Physics, and Scientific Reports.

MONOGRAPHS

Quench dynamics in interacting and superconducting nanojunctions. 2020
Springer Thesis series recognizing outstanding Ph.D. research. ISBN: 978-3-030-36594-3

PATENTS

Improved plano-convex lens projector, ES2570808B1 5/2016
Participation on the invention and design: 50%

GRANTS AND FELLOWSHIPS

Fellowships

- *Dynamics, transport, and non-local properties of topological superconductors* 01/2023 - 01/2025
  Marie Skłodowska-Curie Grant Agreement No. 10103324: Budget 125,192 €
  Top 2% applicant.
- *Dynamics, transport, and non-local properties of topological superconductors* 01/2023 - 01/2026
  Vieira y Clavijo Junior fellowship: Budget 112,828 € (*Declined*)

Grants as principal investigator

- *Andreev bound states in the continuum* 1/2022 - 12/2022
  Nanolund seedling project: Budget 100,000 SEK
- *Transport signatures of odd-frequency superconductivity in nanostructures* 1/2020 - 12/2020
  Nanolund seedling project: Budget 100,000 SEK

Student grants

- Predoctoral grant from the national research agency 1/2013 - 10/2016
  21,500€ per year, including tuition fee
  Department of theoretical condensed matter physics
  Universidad Autónoma de Madrid
  Supervisors: Prof. Alfredo Levy Yeyati and Prof. Álvaro Martín-Rodero
- M.Sc. studentship (4,000 €) 1/2013 - 10/2016
  Master's degree in condensed matter physics and nanotechnology
  Universidad Autónoma de Madrid
- Summer research fellowship from the Ignacio Cirac program chair (2700€) 7/2012 - 9/2012
  Quantum photonics with solids and atoms group

Institute of photonic sciences (ICFO)
Supervisor: Prof. Hugues de Riedmatten

- Spanish undergraduate research fellowship (2,700 €) 1/2012 - 7/2012
  Theoretical physics department II, Universidad Complutense de Madrid
  Supervisor: Dr. Rafael Hernández Redondo

Travel grants

- Lindau Nobel Laureate meeting, Lindau (Germany).
  Granted by Ragnar Söderberg and Lindau Nobel Laureate Meeting foundations, 5500 €
- Workshop in bound states in superconductors and interfaces, Dresden (Germany)
  Granted by Lunds Tekniska Högskola, 8664 SEK
- International school and symposium on nanoscale transport and photonics.
  Granted by Nippon Telegraph and Telephone Corporation, 2600 €

Access to high-performance computational facilities granted by the Spanish supercomputing network

- *Coherent control of Andreev bound states in superconducting quantum dots* 11/2016 - 4/2017
  Estimated cost: 2571.75 €
  Responsible of the project proposal, intermediate reports and justification.
- *Transient transport properties of superconducting quantum dots* 11/2015 - 11/2016
  Estimated cost: 4572.00 €
  Responsible of the project proposal, intermediate reports and justification.
- *Theoretical study of Majorana single-charge transistor using numerical renormalization group* 7/2015 - 11/2015
  Estimated cost: 3817.62 €
  Responsible of the project proposal, intermediate reports and justification.

PARTICIPATION IN FUNDED PROJECTS

Foundations of nonlocal and nonabelian condensed-matter systems. 11/2020 to present
Coordinator: Prof. Karsten Flensberg. P.I. at Lund university: Prof. Martin Leijnse
ERC Synergy grant. Budget: 9,975,273 €

2D hybrid materials as a platform for topological quantum computing. 11/2018 to 10/2020
Coordinator: Prof. Klaus Ensslin. P.I. at Lund university: Prof. Martin Leijnse
Quantera project. Budget: 1,047,258 €

Dynamics, superconductivity and topology in hybrid nanostructures. 1/2017 - 10/2018
Principal investigator: Prof. Alfredo Levy Yeyati.
Granted by MINECO, FIS2017-84860-R. Budget: 157,300 €

Interactions, topology and non-stationary effects in quantum transport. 1/2014 - 1/2018
Principal investigator: Prof. Alfredo Levy Yeyati.
Granted by MINECO, FIS2014-55486-P. Budget: 48,400 €

Correlated electrons in hybrid nanostructures: from transport properties to quantum information processing. 12/2013 - 12/2014
Principal investigator: Prof. Alfredo Levy Yeyati.
Granted by MINECO, FIS2011-26516. Budget: 47,000 €

AWARDS AND DISTINCTIONS

- Junior Scientist Ideas Award 3/2022
  Awarded by Nanolund
- Seal of Excellence Certificate delivered by the European Commission 3/2021
  For the project proposal: *Simulating transport and dynamics of non-local and non-abelian quasiparticles* (STONNES)
  Horizon 2020' s Marie Skłodowska-Curie actions call H2020-MSCA-IF-2020.
- Best question award 12/2020
  SPICE-Workshop Coherent order and transport in spin-active systems. Cash prize 50 €.
- Junior Scientist Ideas Award 4/2020
  Awarded by Nanolund
- Seal of Excellence Certificate delivered by the European Commission 3/2020

For the project proposal: *Dynamical aspects of Majorana fermions out-of-equilibrium: non-local properties and quantum operations* (DYNAMO) Horizon 2020' s Marie Skłodowska-Curie actions call H2020-MSCA-IF-2019.

- Springer Thesis award for outstanding Ph.D. research 8/2019
  Invitation to publish doctoral thesis in Springer Theses series. Cash prize 500 €.

Student awards

- Young researcher 1^{st} prize in material science 12/2017
  Awarded by Instituto Nicolás Cabrera. Cash prize 400 €.
- Best student poster award 8/2016
  Awarded by the International Union of pure and applied Physics.
  33rd international conference on the physics of semiconductors, Beijing.
  Cash prize 2,500 ¥.
- Young researcher 2^{nd} prize in material science 12/2015
  Awarded by Instituto Nicolás Cabrera. Cash prize 100 €.

SUPERVISION EXPERIENCE

Master theses direction

- Jakob Westerberg, *Theory of Time-Dependent Transport and Levitons in Nanowires* 23/4/2021
  Solid State Division, Lund University
  Co-directed with M. Leijnse
- Svend K. Møller, *Detecting Majorana Bound States.* 27/8/2020
  Center for Quantum Devices, Copenhagen University
  Co-directed with K. Flensberg

Bachelor theses direction

- Adrien Delpoux, *Tight-Binding models of Nanowires.* 4/6/2020
  Université Toulouse III, Paul Sabatier
  Co-directed with A. Tsintzis and M. Leijnse

TEACHING EXPERIENCE

Lund university.

- Theory of superconductivity, course for Ph.D. students. 6/12/2019
  Guest lecture on topological superconductivity and Majorana fermions.

Universidad Autónoma de Madrid. Average evaluation 4.5/5 in internal performance assessments

- Experimental Techniques: Optics and Thermodynamics. Courses: 2016-2018
  Third year course of the physics degree.
  Responsible of the weekly practices, holding office hours and grading reports.
- Physics I. Courses: 2015-2018
  Introductory Physics course for chemical engineers: Mechanics and thermodynamics
  Responsible of the weekly homework sessions, holding office hours and grading problem sets.
- Laboratory of general physics. Courses: 2014-2017
  Introductory Physics course, chemical degree.
  Responsible of the weekly practices, holding office hours and grading reports.

PRESENTATIONS

Invited speaker

1. *Superconductor-semiconductor hybrid devices for quantum science and technology* 18/11/2022
   Modern Aspects in Quantum Materials and Quantum Technology. Greifswald University (Germany)
2. *Magnetism and spin-polarized bound states in semiconductor-superconductor-ferromagnetic wires* 14/10/2022
   Northern Lights conference: Magnetism, Topology, and Superconductivity. Reykjavik (Iceland)
3. *Super-semi-ferro as a new platform for quantum technologies* 11/10/2022
   Nanolund annual meeting. Lund (Sweden)
4. *Spin-polarized bound states in semicondutor-superconductor-ferromagnetic platforms* 18/1/2022
   Young investigators online workshop on unconventional superconductivity. online

5. *Time scales for charge-transfer based operations on Majorana systems* 9/9/2019
Q Rob workshop. Microsoft, Redmond (USA)

Oral presentations

1. *Andreev bound states in the continuum* 11/10/2022
Nanolund annual meeting. Lund (Sweden)
2. *Magnetism and spin-polarized bound states in superconductor-ferromagnetic wires* 22/8/2022
29th Meeting of the European Physical society, condensed matter division. Manchester (UK)
3. *Majorana fusion rules in a single-charge topological transistor* 15/3/2022
APS March meeting Chicago (USA)
4. *Charge-transfer based operations on Majorana systems* 15/12/2021
722. WE-Heraeus-Seminar Online
5. *Charge-transfer based operations revealing non-abelian statistics of Majorana states* 15/3/2021
APS March meeting Online
6. *Odd frequency superconductivity in quantum dot systems.* 28/9/2020
Nanolund annual meeting Lund (Sweden)
7. *Revealing non-abelian statistics of Majorana states using charge-transfer operations.* 2/9/2020
Meeting of the European Physical society, condensed matter division, GEFES Online
8. *Time scales for charge-transfer based operations on Majorana systems.* 22/11/2019
Entangled states of matter, CRC183 Berlin (Germany).
9. *Time scales for charge-transfer based operations on Majorana systems.* 9/9/2019
Q–Rob workshop at Microsoft headquarters Redmond (USA).
10. *Quench Dynamics in superconducting nanojunctions: metastability and dynamical phase transitions.* 10/4/2019
Dresden (Germany)
Workshop on Bound states in superconductors and interfaces
11. *Quench dynamics in superconducting nanojunctions.* 15/11/2017
International school and symposium on nanoscale transport and photonics Atsugi (Japan)
12. *Quench dynamics in superconducting nanojunctions: metastability and dynamical Yang-Lee zeros.* 2/8/2017
Nanophysics, from fundamental to applications: reloaded Quy Nhơn
13. *Quench dynamics and counting statistics in interacting nanojunctions: quasi-particles trapping.* 20/9/2016
10^{th} RES (national supercomputing network) conference León (Spain)
14. *Electronic Time Dependent Counting Statistics in interacting Nanojunctions.* 11/4/2016
Nonequilibrium condensed matter and biological system Madrid (Spain)
15. *Non-stationary and noise properties of molecular junctions in the polaronic regime.* 19/12/2015
Nicolás Cabrera Young Research Meeting Miraflores (Spain)

Poster presentations

1. *Magnetism and spin-polarized bound states in semiconductor-superconductor-ferromagnet wires.* 30/05/2022
Novel Quantum Phases in Superconducting Heterostructures Bad Honnef
2. *Optimal manipultion of Majorana bound states using quantum dots.* 12/1/2021
Advances in Scalable Hardware Platforms for Quantum Computing Online
3. *Time scales for charge-transfer based operations on Majorana systems.* 6/11/2019
Quantum life workshop Copenhagen (Denmark).
4. *Time scales of charge transfer based operations of a topological qubit.* 22/7/2019
Summer School Nanotechnology meets Quantum Information Donostia (Spain).
5. *Quench dynamics in superconducting nanojuncions: Andreev bound states formation and dynamical phase transitions.* 30/6/2019 - 5/7/2019
Poster displayed during the Lindau Nobel Laureate meeting Lindau (Germany).
6. *Quench dynamics in superconducting nanojuncions.* 25/7/2018
International Conference on Superlattices, Nanostructures and Nanodevices.

7. *Self-consistent dynamics in interacting nanojunctions: the fate of bistability.* 25/7/2018
International Conference on Superlattices, Nanostructures and Nanodevices Madrid (Spain)
8. *Transient dynamics and Full Counting statistics in superconducting nanojunctions.* 2/8/2015
33^{rd} International Conference on the Physics of Semiconductors Beijing (China)
Best poster award
9. *Non-stationary transport properties of molecular junctions in the polaronic regime.* 30/7/2015
Frontiers of Quantum and Mesoscopic Thermodynamics Prague (Czech Republic)
10. *Non-stationary transport properties of molecular junctions in the polaronic regime.* 3/6/2015
Nano Electromechanical Systems and beyond Bordeaux (France)

Seminars

1. *The Josephson diode effect in supercurrent interferometers* 17/5/2022
Virtual Science Forum (Online)
2. *Quantum transport in topological superconductors: role of non-abelian quasiparticles* 16/6/2021
Aachen University (Germany)
3. *Dynamics of magnetic impurities coupled to superconductors.* 12/5/2021
Niels Bohr institute, University of Copenhagen (Denmark)
4. *Spin-polarized bound states in semiconductor-superconductor-ferromagnetic islands* 16/2/2021
Autonomous University of Madrid (Spain)
5. *Time scales for charge-transfer based operations on Majorana systems* 23/6/2020
Nordita, Stockholm (Sweden)
6. *Odd-frequency superconductivity close to magnetic impurities* 27/5/2020
Lund university (Sweden)
7. *Odd-frequency superconductivity close to magnetic impurities* 17/4/2020
Lund university (Sweden)
8. *Time scales for charge-transfer based operations on Majorana systems* 30/10/2019
Niels Bohr institute, University of Copenhagen (Denmark).
9. *Quench dynamics in interacting and superconducting nanojunctions* 10/4/2019
Nordita, Stockholm (Sweden)
10. *Counting statistics reveal quasiparticle trapping in superconducting nanojunctions* 30/1/2019
Niels Bohr institute, University of Copenhagen (Denmark)
11. *Counting statistics revealing dynamical phase transitions.* 16/11/2018
Lund university (Sweden)
12. *Quench dynamics in interacting and superconducting nanojunctions* 25/7/2018
Lund university (Sweden)
13. *Quench dynamics in interacting and superconducting nanojunctions* 9/7/2018
Würzburg university (Germany)
14. *Counting statistics in superconducting nanojunctions* 13/12/2017
Autonomous University of Madrid (Spain)
15. *Electronic time dependent counting statistics in interacting nanojunctions* 27/472016
Autonomous University of Madrid (Spain)
16. *Inelastic effects in transport through molecular junctions* 11/3/2015
Autonomous University of Madrid (Spain)

Public engagement in science

- Open session of the CIVIS assembly, hybrid, Marseille (France). 27/1/2023
Presentation about: *Non-local states for quantum technologies*
- Farad student job fair, Lund (Sweden). 28/1/2020
- Forskar Grand Prix, Helsinborg (Sweden). 26/9/2019
Short presentation to a young audience of about 200 high school students

INTERNATIONAL SCHOOLS

- Nanotechnology meets Quantum Information, San Sebastián. 22-26/7/2019
- Quantum transport in topological materials, Madrid. 4-8/9/2017
- Capri spring school on transport in nanostructures, Capri. 8-12/4/2013