

Rubén Seoane Souto

PERSONAL INFORMATION	Professorsgatan Lund, Sweden 22100 Website: <a href="https://rubenseoanes.github.io/">https://rubenseoanes.github.io/</a> ORCID: 0000-0002-2978-3534	+46 46 222 3171 <a href="mailto:ruben.seoane_souto@ftf.lth.se">ruben.seoane_souto@ftf.lth.se</a> Researcher ID: N-8483-2016
ACADEMIC POSITIONS	<b>Independent postdoctoral researcher</b> Department of theoretical condensed matter physics, Universidad Autónoma de Madrid  <b>Postdoctoral researcher</b> Center for Quantum Devices, Niels Bohr Institute University of Copenhagen  <b>Researcher</b> Solid state division and Nanolund, Lund university, Visiting researcher at Center for Quantum Devices University of Copenhagen  <b>Posdoctoral researcher</b> Solid state division and Nanolund, Lund university, Visiting researcher at Center for Quantum Devices University of Copenhagen  <b>Adjunct professor</b> (during the Ph.D. studies) Department of theoretical condensed matter physics, Universidad Autónoma de Madrid  <b>Doctoral student</b> 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	1/2022 to present  11/2022 to 12/2022  11/2020 to 10/2022  11/2018 to 10/2020  10/2016-10/2018  1/2013-10/2016
RESEARCH VISITS	<b>Laboratoire Ondes et Matière d'Aquitaine</b> , CNRS Université de Bordeaux Supervisor: Dr. Rémi Avriller	4/2016-7/2016
EDUCATION	<b>Universidad Autónoma de Madrid</b> , Madrid, Spain  Ph.D., Condensed matter physics, nanophysics and biophysics, Thesis title: <i>Quench dynamics in interacting and superconducting nanojunctions</i> . Supervisors: Prof. Alfredo Levy Yeyati and Prof. Álvaro Martín Rodero  Master's degree, Master in condensed matter physics and nanotechnology, Master thesis: <i>Electronic transport through molecular transistors in the polaronic regime</i> Supervisors: Prof. Alfredo Levy Yeyati, Prof. Álvaro Martín Rodero and Prof. Rosa C. Monreal  <b>Universidad Complutense de Madrid</b> , Madrid, Spain  Extended Bachelor in Physics (5 years degree), <ul style="list-style-type: none"><li>Undergraduate thesis: <i>Strong coupling correlation functions and semiclassical strings</i></li><li>Supervisor: Rafael Hernández Redondo, Ph.D.</li><li>Topic: String theory</li></ul>	15/6/2018  7/2013  7/2012

RESEARCH  
INTERESTS

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

REFEREED  
JOURNAL  
PUBLICATIONS

1. **R. Seoane Souto**, M. Leijnse, and C. Schrade, “The Josephson diode effect in supercurrent interferometers” *Phys. Rev. Lett.* **129**, 267702.
2. **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.
3. 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)
4. M. Nitsch, **R. Seoane Souto**, and M. Leijnse, “Interference and parity blockade in transport through a Majorana box” *Phys. Rev. B* **106**, L201305 (2022)
5. 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)
6. **R. Seoane Souto** and M. Leijnse, “Fusion rules in a Majorana single-charge transistor” *SciPost Phys.* **12**, 161 (2022)
7. S. Krøjer, **R. Seoane Souto**, and K. Flensberg, “Demonstrating Majorana nonabelian exchange using fast adiabatic charge-transfer” *Phys. Rev. B* **105**, 045425 (2022)
8. 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)
9. **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)
10. D. Kuzmanovski , **R. Seoane Souto**, and A. V. Balatsky “Persistent current noise in narrow Josephson junctions” *Phys. Rev. B* **104**, L100505 (2021)
11. A. Maiani, **R. Seoane Souto**, M. Leijnse, and K. Flensberg “Topological superconductivity in semiconductor-superconductor-magnetic insulator heterostructures” *Phys. Rev. B* **103**, 104508 (2021)
12. **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)
13. 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)
14. **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)
15. 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)
16. **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)

17. **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)
18. **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)
19. **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)
20. **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)
21. **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. 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” [arXiv:2204.03202](#). (\*Equal author contribution)

#### 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<sup>st</sup> 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<sup>nd</sup> 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 semiconductor-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  
Workshop on Bound states in superconductors and interfaces Dresden (Germany)
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<sup>th</sup> 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 manipulation 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 nanojunctions: 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 nanojunctions.* 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<sup>rd</sup> 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* 27/4/2016  
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

- Farad student job fair, Lund (Sweden). 28/1/2020
- Forskar Grand Prix, Helsingborg (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