

## Rubén Seoane Souto

CONTACT INFORMATION	Professorsgatan Lund, Sweden 22100	+46 46 222 3171 <a href="mailto:ruben.seoane_souto@ftf.lth.se">ruben.seoane_souto@ftf.lth.se</a>
ACADEMIC POSITIONS	<b>Researcher</b> Solid state division and Nanolund, Lund university, Visiting researcher at Center for Quantum Devices University of Copenhagen  <b>Postdoctoral researcher</b> Solid state division and Nanolund, Lund university, Visiting researcher at Center for Quantum Devices University of Copenhagen  <b>Teaching assistant</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	11/2020 to present  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), • Undergraduate thesis: <i>Strong coupling correlation functions and semiclassical strings</i> • Supervisor: Rafael Hernández Redondo, Ph.D. • Topic: String theory	15/6/2018  7/2013  7/2012
RESEARCH INTERESTS	• Quantum transport • Topological states of matter • Mesoscopic superconductivity • Full counting statistics • Quantum computation	

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

1. M. Nitsch, **R. Seoane Souto**, and M. Leijnse, “Interference and parity blockade in transport through a Majorana box” *arXiv:2205.10002*.
2. 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)
3. 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” *arXiv:2203.06644*

REFEREE ACTIVITIES	Regular referee of journals of the American Physical Society, including Physical Review Letters, Physical Review B and Physical Review Research. Referee of Scientific Reports.	
MONOGRAPHS	<i>Quench dynamics in interacting and superconducting nanojunctions.</i> Springer Thesis series recognizing outstanding Ph.D. research. ISBN: 978-3-030-36594-3	2020
PATENTS	Improved plano-convex lens projector, <a href="#">ES2570808B1</a> Participation on the invention and design: 50%	5/2016
PARTICIPATION IN FUNDED PROJECTS	<p><i>2D hybrid materials as a platform for topological quantum computing.</i> 11/2018 to present Coordinator: Prof. Klaus Ensslin. P.I. at Lund university: Dr. Martin Leijnse Quanterra project. Budget: 1,047,258 €</p> <p><i>Dynamics, superconductivity and topology in hybrid nanostructures.</i> 1/2017 - 10/2018 Principal investigator: Prof. Alfredo Levy Yeyati. Granted by MINECO, FIS2017-84860-R. Budget: 157,300 €</p> <p><i>Interactions, topology and non-stationary effects in quantum transport.</i> 1/2014 - 1/2018 Principal investigator: Prof. Alfredo Levy Yeyati. Granted by MINECO, FIS2014-55486-P. Budget: 48,400 €</p> <p><i>Correlated electrons in hybrid nanostructures: from transport properties to quantum information processing.</i> 12/2013 - 12/2014 Principal investigator: Prof. Alfredo Levy Yeyati. Granted by MINECO, FIS2011-26516. Budget: 47,000 €</p>	
AWARDED GRANTS AND FELLOWSHIPS	<p>Research grants as principal investigator:</p> <ul style="list-style-type: none"> <li>• <i>Andreev bound states in the continuum</i> 1/2022 - 12/2022 Nanolund seedling project: Budget 100,000 SEK</li> <li>• <i>Transport signatures of odd-frequency superconductivity in nanostructures</i> 1/2020 - 12/2020 Nanolund seedling project: Budget 100,000 SEK</li> </ul> <p>Student grants:</p> <ul style="list-style-type: none"> <li>• 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</li> <li>• M.Sc. studentship (4,000 €) 1/2013 - 10/2016 Master's degree in condensed matter physics and nanotechnology Universidad Autónoma de Madrid</li> <li>• 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</li> <li>• Spanish undergraduate research fellowship (2,700 €) 1/2012 - 7/2012 Theoretical physics department II, Universidad Complutense de Madrid Supervisor: Dr. Rafael Hernández Redondo</li> </ul> <p>Travel grants</p> <ul style="list-style-type: none"> <li>• Lindau Nobel Laureate meeting, Lindau (Germany). Granted by Ragnar Söderberg and Lindau Nobel Laureate Meeting foundations, 5500 €</li> <li>• Workshop in bound states in superconductors and interfaces, Dresden (Germany) Granted by Lunds Tekniska Högskola, 8664 SEK</li> <li>• International school and symposium on nanoscale transport and photonics. Granted by Nippon Telegraph and Telephone Corporation, 2600 €</li> </ul> <p>Access to high-performance computational facilities granted by RES (Spanish supercomputing network).</p> <ul style="list-style-type: none"> <li>• <i>Coherent control of Andreev bound states in superconducting quantum dots</i> 11/2016 - 4/2017</li> </ul>	

	Estimated cost: 2571.75 €	
	Responsible of the project proposal, intermediate reports and justification.	
	<ul style="list-style-type: none"> <li>• <i>Transient transport properties of superconducting quantum dots</i> 11/2015 - 11/2016</li> </ul>	
	Estimated cost: 4572.00 €	
	Responsible of the project proposal, intermediate reports and justification.	
	<ul style="list-style-type: none"> <li>• <i>Theoretical study of Majorana single-charge transistor using numerical renormalization group</i> 7/2015 - 11/2015</li> </ul>	
	Estimated cost: 3817.62 €	
	Responsible of the project proposal, intermediate reports and justification.	
AWARDS AND DISTINCTIONS	<ul style="list-style-type: none"> <li>• Junior Scientist Ideas Award 3/2022 Awarded by Nanolund</li> <li>• Seal of Excellence Certificate delivered by the European Commission 3/2021 For the project proposal: <i>Simulating transport and dynamics of non-local and non-abelian quasiparticles</i> (STONNES) Horizon 2020' s Marie Skłodowska-Curie actions call H2020-MSCA-IF-2020.</li> <li>• Best question award 12/2020 SPICE-Workshop Coherent order and transport in spin-active systems. Cash prize 50 €.</li> <li>• Junior Scientist Ideas Award 4/2020 Awarded by Nanolund</li> <li>• Seal of Excellence Certificate delivered by the European Commission 3/2020 For the project proposal: <i>Dynamical aspects of Majorana fermions out-of-equilibrium: non-local properties and quantum operations</i> (DYNAMO) Horizon 2020' s Marie Skłodowska-Curie actions call H2020-MSCA-IF-2019.</li> <li>• Springer Thesis award for outstanding Ph.D. research 8/2019 Invitation to publish doctoral thesis in Springer Theses series. Cash prize 500 €.</li> </ul>	
	Student awards	
	<ul style="list-style-type: none"> <li>• Young researcher 1<sup>st</sup> prize in material science 12/2017 Awarded by Instituto Nicolás Cabrera. Cash prize 400 €.</li> <li>• 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 ¥.</li> <li>• Young researcher 2<sup>nd</sup> prize in material science 12/2015 Awarded by Instituto Nicolás Cabrera. Cash prize 100 €.</li> </ul>	
SUPERVISION EXPERIENCE	Master theses direction	
	<ul style="list-style-type: none"> <li>• Jakob Westerberg, <i>Theory of Time-Dependent Transport and Levitons in Nanowires</i> 23/4/2021 Solid State Division, Lund University Co-directed with M. Leijnse</li> <li>• Svend K. Møller, <i>Detecting Majorana Bound States.</i> 27/8/2020 Center for Quantum Devices, Copenhagen University Co-directed with K. Flensberg</li> </ul>	
	Bachelor theses direction	
	<ul style="list-style-type: none"> <li>• Adrien Delpoux, <i>Tight-Binding models of Nanowires.</i> 4/6/2020 Université Toulouse III, Paul Sabatier Co-directed with A. Tsintzis and M. Leijnse</li> </ul>	
TEACHING EXPERIENCE	Lund university.	
	<ul style="list-style-type: none"> <li>• Theory of superconductivity, course for Ph.D. students. 6/12/2019 Guest lecture about topological superconductivity and Majorana fermions.</li> </ul>	
	Universidad Autónoma de Madrid. Average evaluation 4.5/5 in internal performance assessments	
	<ul style="list-style-type: none"> <li>• Experimental Techniques: Optics and Thermodynamics. Courses: 2016-2018</li> </ul>	

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 Oral presentations

1. *Majorana fusion rules in a single-charge topological transistor* 15/3/2022  
APS March meeting Chicago (USA)
2. *Spin-polarized bound states in semiconductor-superconductor-ferromagnetic platforms* 18/01/2022  
**Invited speaker**, Young investigators workshop on unconventional superconductivity Online
3. *Charge-transfer based operations on Majorana systems* 15/12/2021  
722. WE-Heraeus-Seminar Online
4. *Charge-transfer based operations revealing non-abelian statistics of Majorana states* 15/3/2021  
APS March meeting Online
5. *Odd frequency superconductivity in quantum dot systems.* 28/9/2020  
**Invited speaker**. Nanolund annual meeting Lund (Sweden)
6. *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
7. *Time scales for charge-transfer based operations on Majorana systems.* 22/11/2019  
Entangled states of matter, CRC183 Berlin (Germany).
8. *Time scales for charge-transfer based operations on Majorana systems.* 9/9/2019  
Q-Rob workshop at Microsoft headquarters Redmond (USA).
9. *Quench Dynamics in superconducting nanojunctions: metastability and dynamical phase transitions.* 10/4/2019  
Workshop on Bound states in superconductors and interfaces Dresden (Germany)
10. *Quench Dynamics in superconducting nanojunctions.* 15/12/2017  
**Invited speaker**. Nicolás Cabrera Young Research Meeting Miraflores (Spain)
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