Rubén Seoane Souto

CONTACT INFORMATION

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ACADEMIC POSITIONS

Researcher 11/2020 to present
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

Teaching assistant (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
- Full counting statistics
- Quantum computation

REFEREED JOURNAL PUBLICATIONS

1. 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 (accepted in NPJ Quantum Materials)

2. **R. Seoane Souto** and M. Leijnse, "Fusion rules in a Majorana single-charge transistor" SciPost Phys. **12**, 161 (2022)

3. S. Krøjer, **R. Seoane Souto**, and K. Flensberg, "Demonstrating Majorana nonabelian exchange using fast adiabatic charge-transfer" Phys. Rev. B **105**, 045425 (2022)

4. 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)

5. **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)

6. D. Kuzmanovski , **R. Seoane Souto**, and A. V. Balatsky "Persistent current noise in narrow Josephson junctions"Phys. Rev. B **104**, L100505 (2021)

7. A. Maiani, **R. Seoane Souto**, M. Leijnse, and K. Flensberg "Topological superconductivity in semiconductor-superconductor-magnetic insulator heterostructures"Phys. Rev. B **103**, 104508 (2021)

8. **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)

9. 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)

10. **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)

11. 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)

12. **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)

13. **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)

14. **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)

15. **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)

16. **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)

17. **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. M. Nitsch, **R. Seoane Souto**, and M. Leijnse, "Interference and parity blockade in transport through a Majorana box" arXiv:2205.10002.
2. **R. Seoane Souto**, M. Leijnse, and C. Schrade, "The Josephson diode effect in supercurrent interferometers" arXiv:2205.04469.
3. 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 of 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%

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 €

Awarded grants and fellowships

Research 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 RES (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.

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 about 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

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 semicondutor-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
   Dresden (Germany)
   Workshop on Bound states in superconductors and interfaces
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^{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

- 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