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PERSONAL DATA

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CURRENT POSITION

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Position	Full Professor (Catedrática de Universidad)	Fecha inicio	22-12-2020
UNESCO code	221029 - Física del Estado Sólido		
Keywords	Quantum Transport, Strongly Correlated systems, Topological materials, Thermoelectricity, Quantum Thermodynamics		

EDUCATION

Licenciatura/Grado/Doctorado	University	Año
Degree in Physics	Autónoma de Madrid	1996
PhD in Physics	Autónoma de Madrid	2002

SCIENTIFIC PRODUCTION

- Sexenios evaluated positively by the CNAI: 4 (last recognized year for the sexenio in 2020)
- Publications: 90
 - Interdisciplinary Physics: 16 Physical Review Letters + 1 Comment.
 - Condensed matter Physics: 41 Physical Review B (5 Rapid Communications),
 - 5 New Journal of Physics, 1 Featured in Physics 2 Editorial Suggestion
- Citations (1) Google Scholar: 3334 (2) Scopus 2693

ACADEMIC TRAYECTORY

- 2020 Full Professor (Catedrática de Universidad) @ UIB
- 2011 Professor (Profesor Titular) @ UIB
- 2010 Associated Researcher at the Institute of Interdisciplinary Physics and Complex Systems (UIB-CSIC)
- 2008-2011 Tenured Professor (Profesor Contratado Doctor I3) @ UIB
- 2005-2008 Ramón y Cajal Fellowship @ UIB
- 2002-2005 Marie Curie postdoc position/Manep postdoc @ Geneva University (Head of the Lab: Markus Büttiker)
- 1997-2002 PhD *Nonequilibrium Transport Properties in Low Dimensional Systems: Kondo Effect in Quantum Dots and Nonlinear Dynamics in Multiple-Quantum-Well Systems*. Supervised by Prof. Investigación Gloria Platero (ICMM, CSIC).

RESEARCH FIELDS ALONG MY CAREER

1. **Quantum transport in artificial magnetic impurities.** During all my scientific career I have been interested in problems related with many-body effects in quantum transport. For that I have become a world reference for the research of quantum transport in correlated systems such as artificial magnetic impurities that exhibit Kondo effect. To cite some recent examples I have reported studies on the electrical transport in AC driven interacting quantum capacitors both in the adiabatic and the photon-assisted tunneling regime. Besides quite cited investigation has been those in which non conventional contacts are considered coupled to either a single to double dots such as ferromagnetic leads, superconductors, and topological contacts. Additionally I have investigate the charge transport in carbon nanotubes that exhibit the SU(4) Kondo effect and in trimer in which three quantum dots show the SU(3) Kondo physics. The most recent work is related with the Kondo effect in the presence of thermal gradients.
2. **Thermoelectricity and Quantum thermodynamics.** After my postdoctoral staying at the University of Geneva in the group of Prof. Markus Büttiker I started to investigate the thermoelectrical transport in nanostructures. For that I developed a formalism within the Scattering Theory to address thermoelectrical transport when a voltage and thermal gradient is applied to the sample. This formalism has been applied by other researchers in their investigations and the paper in which the theory is described counts with numerous citations becoming a referent in the field of Thermoelectricity in nanostructures. During the last five years I have expanded my knowledge towards the Quantum thermodynamics. Here I mention important contributions in the field of fluctuation theorems out of equilibrium, quantum Maxwell demon protocols and proposals for nano thermal machines. Quantum Thermodynamics is becoming a strong interest in my research these days in which I am incorporating new methods (quantum trajectories) in combination with thermodynamics concepts to deal with artificial intelligence algorithms (Quantum Machine Learning)
3. **Topological state** The investigation on non-local quantum states as Majorana states has fueled an intense activity in the field. I joined quite successfully to the race for the detection of such states by publishing interesting contributions in Majorana nanowires, Topological capacitors and in the the interplay between strongly correlated phenomena and Majorana physics in the heat transport.

RELEVANT SCIENTIFIC ACHIEVEMENTS

Publications. I have around 90 publications within the precedent research lines. There are 10 publications with more than 100 citations. Some of these publications are direct collaborations with experimental groups. I have highlighted some publications that reflect better my consolidate trajectory

1. Mesoscopic Coulomb drag, broken detailed balance and fluctuation relations R. Sánchez, R. López, D. Sánchez, and M. Büttiker, **Physical Review Letters** 104, 076801 (2010). We predict the occurrence of the Coulmb drag effect in double quantum dots coupled electrostatically. We additionally demonstrated the fulfillment of the nonlinear fluctuation relations in the nonlinear transport regime. **Experimental collaboration.**
2. Josephson current in strongly correlated double quantum dots R. Zitko, M. Lee, R. López, R. Aguado, M-S. Choi, **Physical Review Letters** 105, 116803 (2010). We investigate the Josephson current when it exhibits a 0 or π -junction behavior in double quantum dots coupled in a series. This is the minimal model, a dimer, to understand the interplay between Kondo physics and states that are precursors of topological states, the Shiba states.
3. Fluctuations relations for spintronics, R. López, J-S. Lim, and D. Sánchez, **Physical Review Letters** 108, 246603 (2012). Here, we investigate the fluctuation theorems in a topological system out of equilibrium.
4. *Transport measurement of Andreev bound states in a Kondo-correlated quantum dot*, B-K. Kim, Y-H. Ahn, J-J. Kim, M-S. Choi, M-H. Bae, K. Kang, J-S. Lim, R López, Phys. Rev.

- Lett. **110** 076803 (2013). This is a collaboration with an experimental group. In this work we analyze the transition from the 0-junction behavior to π -junction behavior when the Kondo temperature changes with respect to the superconducting gap. The super current reflects such transition as experimentally is demonstrated. **Experimental collaboration.**
5. Scattering theory of nonlinear thermoelectric transport, D. Sánchez, and R. López, **Physical Review Letters** 110 (2), 026804 (2013). Formulation of a gauge invariance theory for the nonlinear transport in nano conductors that are driven by electrical and thermal gradients.
 6. Cotunneling Drag Effect in Coulomb-Coupled Quantum Dot, A. J. Keller, J. S. Lim, David Sánchez, Rosa López, S. Amasha, J. A. Katine, Hadas Shtrikman, and D. Goldhaber-Gordo, **Physical Review Letters** 117, 066602 (2016). This is a experimental collaboration in which the Coulomb drag effect was measured in double quantum dots in the cotunneling regime. **Experimental collaboration.**
 7. Thermally Driven Out-of-Equilibrium Two-Impurity Kondo System, M.A. Sierra, R. López, J-S. Lim, **Physical Review Letters** 121, 096801, (2018). The two-impurity Kondo problem is addressed from the thermoelectrical point of view. We consider a thermal gradient applied to the contacts and we investigate the heat and charge currents and the influence of such gradients in the Kondo to the antiferromagnetic phase.
 8. Nonlinear Chiral Refrigerators. D. Sánchez, R. Sánchez, R. López, B. Sothmann, **Physical Review B** 99, 245304 (2019). We propose a refrigerator being a mutiterminal topological system. In particular we consider a three terminal quantum Hall bar in which we insert two scatters, two quantum dots. From the chirality and the energy dependent transmission at the scatters the heat at the third terminal can be extracted working the system as a refrigerator.

FUNDED PROJECTS

During my career I have been involved in numerous researchers projects (European Projects, National ones, etc). First I was enrolled as a participant and in the last eight years I have become the principal investigator of some of them. Currently I am the PI in three projects (from the national research agency, the local Balearic agency and the CSIC through a i-LINK project. Below I list some of the most recent projects

1. Project Title: Unidad de Excelencia Maria de Maeztu (Information processing in and by complex systems.) (MDM-2017-0711). Duration: from 01/07/2018 to 30/06/2022. Budget: 2.000.000 euros. PI: Claudio Miraso, Ingo Fisher. Budget: 2 million euros.
2. Project Title: Quantum Transport and Thermodynamics: New Avenues in Quantum Materials, PID2020-117347GB-I00, Proyectos de I+D de "Excelencia" 2021. Duration from 01/10/2021 to 31/09/2020. PI: Rosa López, Llorenç Serra. 70.000 euros.
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4. Project Title: Quantum transport and thermodynamics: New Avenues in Quantum Materials PDR2020-12, Funding Agency: GOIB, Comunidad Autónoma de las Islas Baleares. Duration: from 01/01/2022 to 31/12/2024. Amount: 37.200 euros. PI: R López
5. Project Title: LINKB20072. Funding Agency: CSIC. Duration 01/01/2022-31/12/2023. Budget: 23.600 euros.
6. Project Title: Transporte en Materiales Cuánticos en la Nanoscala MAT2017-82639. Proyectos de I+D de "Excelencia" 2017. Duration from 01/01/2018 to 31/12/2020. Principal investigator: Rosa López, David Sánchez. 84.000 euros
7. Project Title: Spin, energy and topology at quantum transport (SET@QT) FIS2014-52564-P. Proyectos de I+D de "Excelencia" 2014. Duration: from 01/01/2015 to 31/12/2017. I Principal investigator: Rosa López, David Sánchez.
8. Project Title: Título del proyecto: Termoelectricidad: nuevas teorías. MAT2016-82015-RED. Duration (2018-2020). Investigador Principal Red Andrés Cantarero. Investigador Principal nodo UIB-IFISC Rosa López. Budget: 18.500 euros.
9. . Project Title: Quantum Thermodynamics. COST - Action Cost. 2406 - EC DG-RTD Duration: from 2013 to: 2016. Investigador/a Principal: Janet Anders.

- 10.. Project Title:: Transporte e Información en Sistemas Cuánticos. Programa Nacional de Investigación Fundamental No Orientada - Ministerio de Ciencia e Innovación. FIS2011 23526. Budget : 183.920 euros. Duration: 2012 to: 2014. Principal Investigator: Llorens Serra Crespi.
11. Project Title: Red Española de Física de sistemas fuera de equilibrio. ACCO - Acción complementaria nacional Empresa/Administración financiadora: MECI - Ministerio de Educación y Ciencia Número de proyecto/contrato: FIS2010-11438-E. Budget : 15.000 euros .Duration: from 2012 tp 2012. Principal Investigator: Ignacio Paganobarraga.

CONFERENCES

I have attended to about 60 scientific meetings (Conferences/Workshops/Schools). My participation has been always very active presenting either posters or contributed/invited talks. Here I list some of recent invited talks during my career

1. Title: *Magnetic fluctuations in hybrid multiterminal systems*. 20th International Conference on Noise and Fluctuations (Pisa, Italy, 2009)
2. Title: *Josephson current in double quantum dots*. Workshop: Out of equilibrium systems, Nonlinear systems, nanoscience and fluid dynamics (Madrid, Spain 2010)
3. Title: *The two impurity Kondo effect revisited*. Conference on Quantum Engineering of States and Devices (Obergurl, Austria, 2010).
4. Title: *Nonliner relations in coupled mesoscopic conductors*. Workshop on the physics of micro and nano scale systems (Ystad, Swden 2010)
5. Title: *Josephson current in carbon nanotubes with spin orbit interaction*. Workshop: Charge and heat dynamics in nano-systems (Orsay, France 2011)
6. Title: *Kondo effect in ferrmomagnetic doubles quantum dots*. Congreso: Conference EP2DS 19 (Tallahasse, EE.UU 2011)
7. Title: *Josephson current in carbon nanotubes*. GEFES meeting. Reunión Bienal del Grupo Especializado de Estado Sólido (Sevilla, Spain 2012)
8. Title: *Semi plenaria Scattering theory of Thermoelectrical nonlinear transport*. Congreso: 27th International Conference on Low Temperature (Buenos Aires, Argentina 2014) (Semi-plenary talk)
9. Title: *Majorana thermoelectrical detection*. Congreso: 25th Conference of the Condensed Matter Division of the European Physical Society (Paris, France 2014)
10. Title: *AC and DC transport in RC quantum circuits*. Quantum Thermodynamics conference COST (Berlin 2014).
11. Title: *Coulomb drag in quantum dots*: Conference: AC driven quantum systems. (Bariloche 2016)
12. Title: *The Kondo effect in Thermoelectrics*. International Workshop on Magnetism & Superconductivity at the Nanoscale (Comarruga 2019).
13. Title: Nonchiral refrigerators. Conference (online). Quantum thermodynamics of Non-Equilibrium Systems, San Sebastian (2020).

ACTIVITIES I+D+I

Organization of Conferences/workshops and other scientific events:

I have been co-organizer of four scientific meetings (4 international + 1 national) that were funded by scientific institutions

- 1.- Majorana states in Condensed Matter: Towards topological quantum computation, 2017 International conference.
- 2.- 2nd Conference on Quantum Thermodynamics, 2015. International conference.
- 3.- Nonlinear spin and charge transport through nanoscopic systems, 2011. International conference
- 4.- Nanomediterráneo 3, 2011. Spanish meeting.
- 5.- Nonequilibrium Fluctuation Relations In Quantum Systems, 2011. International conference.

Participation in committees: I have participated in numerous tesis committees (in two as opponent) and scientific advisory committee in conferences/workshops. I have been member of committees for hiring postdoctoral and tenured positions (as PCD, TU, and CU). I am referee in diverse scientific agencies: ANEP, NSF, ERC. Evaluator in the Ramón y Cajal, Spanish Research Grant Program. Participation in the "Comision Técnica para la evaluación de proyectos I+D del área de Física (FYA)" in 2019. Referee of numerous scientific journals, PRL, Entropy, NJP, PRB, Nanoletters, etc

Relevant positions: Head of the Physics Doctoral School since 2019. Elected member in the IFISC direction board representing staff researchers: 2012-2016.

External Collaborations: During my scientific career my I have collaborated with a large number of scientists with whom I still maintain a lot of interaction and we develop together research works. Special mention to collaborators in South Korea (Jong Soo Lim, Minchul Lee, Mahn Soo Choi, Sungguen Ryu, Sung-Yong Hwang, Kun Woo Kim) in Slovenia (Rok Zitko) and Pascal Simon (France). I collaborate quite closely with experimental groups and recently I have a lot of activity with the group of Prof. Hongqi Xu (Beijin University) and Prof. Albert Morpurgo (Geneva University). My main research activity consists of working closely with other senior researchers and postdocs.

Outreach events:

- Press publications (La revolución en miniatura. <https://www.elmundo.es/elmundo/2011/12/13/baleares/1323764299.html>, Exploradores de la materia Exótica, <https://www.elmundo.es/baleares/2016/10/19/58073482268e3ecd708b45c8.html>, El demonio Cuántico de Maxwell, <https://www.elmundo.es/baleares/2018/01/31/5a71851ee2704e56408b456e.htm>
- Participation in numerous outreach events organized by the IFISC and the UIB (seminars at secondary schools, Pint of Science, el día de la niña y la Ciencia, the week of Science, etc)

STUDENT TRAINING AND TEACHING

I summarized my long trajectory in training and teaching students for more than two decades. I have supervised four master thesis students. And four postdoctoral researchers. Additionally I have supervised five final degree project (currently I supervised two more). I teach in two Master degrees @ UIB and @ IFISC. Teaching in Physics degree during 20 years with more than 2000 hours of teaching (more of 200 hours in master courses). I have supervised two PhD theses and I supervised a recent PhD student (funded by the Maria de Maeztu program) working in Quantum thermodynamics and Quantum machine learning. The two PhD works that I supervised are:

- Javier Osca Cotarelo, Majorana physics in hybrid nanowires, topological phases and transport. Cum laude. 2016. Co-supervised with Dr. Llorens Serra.
- Guillem Rosselló Rosselló, Heat and Charge transport in nanostructures: interference, AC-driving, environment, and feedback. Cum Laude.