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mission 10 000 conference

QUANTUM SCIENCE & TECHNOLOGIES

INL, BRAGA, PORTUGAL

October 22nd - 24th, 2019

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Quantum Science & Technologies

October 22nd - 24th, 2019 | **INL**, Braga (Portugal)

nanoGateway International Conference

Mission 10 000: QUANTUM SCIENCE & TECHNOLOGIES

Welcome to the nanoGateway International Conference Mission 10.000: Quantum Science & Technologies

Information technologies have been shaping our civilisation in the last four decades. They determine the ways we work, our social interactions, our entertainment, healthcare, financial markets, weather forecast, as well as our potential to do research and innovation. Information technologies have been based both on advances in a somewhat limited set of materials (like semiconductors) and on the use of classical information.

We are now witnessing the emergence of new paradigms. On the one hand, the advent of quantum information and the resulting application areas of **quantum computing, quantum simulation, quantum sensing and quantum communications**. On the other hand, the quest of functional quantum materials whose collective quantum properties can be harnessed to deliver new functionalities. Thus, after 100 years since the birth of **quantum physics,** the exploration of **quantum materials, quantum technologies** and **quantum information** are one of the most active cutting edge research areas.

The International Conference of Quantum Science and Technologies, an event sponsored by the nanoGateway Interreg project, brought together experts from all over the world to present their latest results in the four following areas: *Applied Quantum Computing & Quantum Simulation, Quantum Sensing and Imaging, Quantum Materials for Quantum Technologies* and *Quantum Software Engineering.*

The nanoGateway Initiative

NanoGateway is a collaborative multi-actor initiative to increase the impact of research in issues of social relevance, involving all the relevant actors to solve complex challenges.

The **nanoGateway project** is co-funded under the Interreg V-A Spain-Portugal Cooperation Programme (POCTEP) and is lead by the INL involving the POCTEP Regional Development Agencies.

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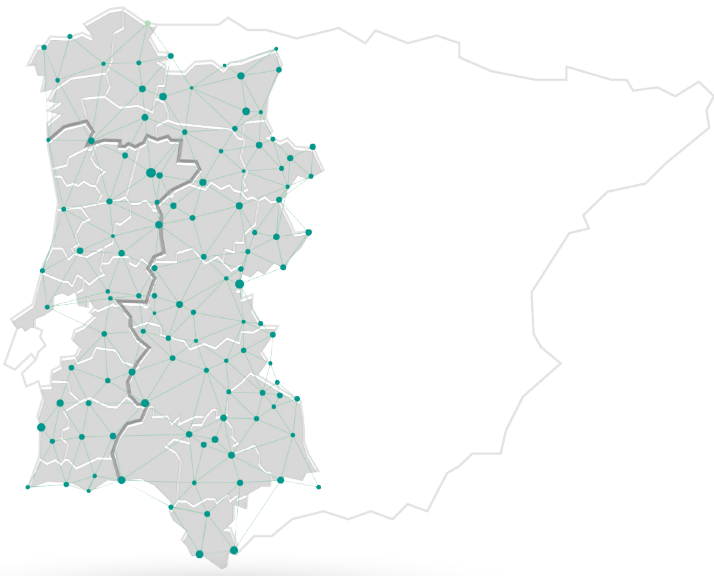

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Welcome to the International Conference Mission 10.000: Quantum Science & Technologies

Closing the cycle of the Mission 10.000 Conferences, INL hosted the Mission 10.000: Quantum Science and Technologies between 22-24 October.
After the success of 2018, this new program gave continuity to the nanoGateway collaborative initiative that aims to solve complex challenges by increasing the impact of research on issues of social relevance and involving all relevant actors of the POCTEP region.
In the last years, a number of significant developments have occurred that go under the name of "Second Quantum Revolution". This movement has the potential to unleash several disruptive technologies, and the Quantum Technologies have the potential to profoundly change several economic sectors, including secure internet communications, logistics, finance, drug design, simulation of complex materials, and others. These changes will have winners and losers. Therefore, it is of the utmost importance that that academic organizations, companies, countries, and transnational organizations outline their Quantum Strategy, trying to exploit their potential to benefit from the Second Quantum Revolution. The Quantum Technologies are directly connected to Nanotechnology - a Key Enabling Technology - and the demands we are now identifying are linked to the further consequences of digitalisation and globalization fostering disruptive innovations. Consequently, immense immense high-value opportunities will prevail. The core of the International Conference Mission 10.000: Quantum Science and Technologies was to articulate the importance and to foster an increased participation, interaction and networking, and to propitiate new dialogues, as well as to find partners for collaborative explorations.
For three days, we welcomed more than 130 participants in an event powered by three Keynote speakers, 16 invited talks, several contributed talks and poster presentations.
We had the opportunity to witness the emergence of new paradigms after 100 years of the birth of quantum physics, the exploration of quantum materials, quantum technologies and quantum information. Moreover, we had the pleasure to attribute two awards for the Best Poster and Best Oral Presentation in this initiative that brought together experts from all over the world.

Sincerely,

Prof. Dr Lars Montelius,
DG, INL

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PROGRAMME | October 22nd, 2019

8h45 - 9h10 Registration

OPENING SESSION

9h15 **Lars Montelius,** Director-General, INL

MORNING SESSION

Session Chair: Nuno Peres

KEYNOTE SPEAKER

09h30 *:: Layered Quantum Materials*

Frank Koppens, ICREA Professor, ERC Starting Grant Award, ERC Consolidator Grant Award, Quantum Nano-Optoelectronics Group Leader, ICFO

Session Chair: Nuno Peres

INVITED TALK

10h15 *:: Quantum Information using Nonlinear Graphene Plasmonics*

Lee Rozema, Templeton Independent Research Fellow, Faculty of Physics, University of Viena

Q. Plasmonics

Session Chair: Nuno Peres

CONTRIBUTED TALK

10h45 *:: Itinerant Fermion Description of Topological Spin Waves in CrI3 Monolayers ::* António Costa, INL

11h00 Coffee break

Session Chair: Nuno Peres

CONTRIBUTED TALKS

Q. Imaging

11h30 *:: Excitonic Core-Shell Nanoparticles with Plasmon-Like Response ::* Sara Núñez Sánchez, University of Vigo

11h45 *:: Strong Coupling between Surface Exciton Polaritons and Complementary Optical Modes in Multicomponent Thin Film Structures ::* William P. Wardley, INL

Session Chair: Nuno Peres

INVITED TALK

Q. Plasmonics & Photonics

12h00 *:: Search for Quantum and Nonlocal Electrodynamics in Plasmonic Nanostructures*

Asger Mortensen, Professor, VILLUM Investigator, Quantum Plasmonics, University of Southern Denmark

12h30 Lunch break

Networking Opportunity

AFTERNOON SESSION

Session Chair: Pieter de Beule

INVITED TALK

Q. Imaging

15h00 *:: Quantum Imaging with Incoherently Scattered Light from a Free-Electron Laser*

Joachim von Zanthier, Associate Professor and Group Leader of Quantum Optics and Quantum Information Institute of Optics, Information and Photonics. Friedrich-Alexander University Erlangen-Nürnberg, Germany

Session Chair: Pieter de Beule

CONTRIBUTED TALK

PROGRAMME | October 22nd, 2019

Session Chair: Pieter de Beule

15h45 — **POSTER SESSION & Coffe Break** — Collaboration opportunities

Session Chair: Jana Nieder — **INVITED TALK**

17h15 — *:: Quantum Sensing and Imaging of 2D Magnets* — Q. Sensing

Lucas Thiel, Research, Quantum Sensing Group, Department of Physics, University of Basel

Session Chair: Jana Nieder — **INVITED TALK**

17h45 — *:: Anomalous Photovoltaic Effects in Monolayer MoSe2* — Q. Sensing

Jorge Quereda Bernabeu, Postdoctoral Researcher, Nanotechnology Research Group,

PROGRAMME | October 23rd, 2019

8h30 - 9h00 Registration

MORNING SESSION

Session Chair: Joaquín Rossier — **INVITED TALK**

9h15 — *:: Kitaev Models and Materials: Quo vadis* — Q. Topological Materials

Roser Valentí, Physics Professor, University of Frankfurt

Session Chair: Joaquín Rossier — **INVITED TALK**

9h45 — *:: Introduction to Majorana-based Topological Qubits* — Q. Topological Materials

Ramón Aguado, CSIC

Session Chair: Joaquín Rossier — **CONTRIBUTED TALKS** — Q. Topological Materials

10h15 *:: Topologically protected Quantization of work ::* Bruno Mera, IST - Instituto Superior Técnico

10h30 *:: Topological Insulator Quantum dots Grown by Molecular Beam Epitaxy ::* Marcel Claro, INL

10h45 *:: Anomalous Kerr Effect in Two-Dimensional Massive Dirac Materials ::* Gonçalo Catarina, INL

11h00 Coffee break

Session Chair: Ernesto Galvão — **INVITED TALK**

11h30 — *:: From Quantum Computing to Quantum inspired Algorithms* — Q. Information & Q. Simulation

Juan José García Ripoll, Group Leader, Instituto de Física Fundamental (IFF), CSIC

Session Chair: Ernesto Galvão — **INVITED TALK**

12h00 — *:: Certification of Integrated Quantum Platforms via Machine Learning* — Q. Information & Q. Simulation

Fabio Sciarrino, Associate Professor, Department of Physics, University Sapienza

PROGRAMME | October 23rd, 2019

12h30	Lunch break	Networking Opportunity

AFTERNOON SESSION

Session Chair: Enrique Diez Fernández — KEYNOTE SPEAKER

15h00	*:: Spin And Charge Transport In 2D Materials and Heterostructures* **Jeanie Lau,** Physics Professor, Ohio State University	Q. Materials

Session Chair: Enrique Diez Fernández — CONTRIBUTED TALK

15h45	*:: Competition between Canted Antiferromagnetic and Spin-Polarized Quantum Hall states at v=0 in Single Layer Graphene on a Ferrimagnetic Insulator ::* **Mario Amado,** University of Salamanca, University of Cambridge	Q. Materials
16h00	*:: Excitonic effects on the Magneto-Optical Properties of Ferromagnetic 2D Materials ::* **Alejandro Molina,** INL	Q. Topological Materials

Session Chair: Enrique Diez Fernández

16h15	POSTER SESSION & Coffe Break	Collaboration opportunities

Session Chair: Ramón Aguado — INVITED TALK

17h15	*::Two-Dimensional Orbital Hall Insulators* **Tatiana Rappoport,** Associate Professor, Physics Institute, Federal University of Rio de Janeiro	Q. Materials

Session Chair: Ramón Aguado — CONTRIBUTED TALK

17h45	*:: Quantum Advantage from Energy Measurements ::* **Leonardo Novo,** ULB Brussels	Q. Computing
18h00	*:: Quantum Berry Phase Estimation ::* **Bruno Murta,** INL	
18h15	*:: Quantum Oblivious Keys for Secure Multiparty Computation ::* **Armando Pinto,** University of Aveiro	

PROGRAMME | October 24th, 2019

8h30 - 9h00	Registration

MORNING SESSION

Session Chair: Luís Barbosa — KEYNOTE SPEAKER

9h15	*:: Non-classicality, quantum resources and quantum advantage* **Samson Abramsky,** Professor, Universtity of Oxford	Q. Information & Q. Programming

Session Chair: Luís Barbosa — INVITED TALK

10h00	*:: A Gentle Introduction to Quantum Programming* **Ugo dal Lago,** Associate Professor, University of Bologna	Q. Information & Q. Programming

Quantum Science & Technologies

22nd - 24th of October, 2019 | INL, Braga (Portugal)

nanoGateway International Conference

ROGRAMME | October 24th, 2019

Session Chair: Luís Barbosa — **CONTRIBUTED TALKS**

10h30	*:: A dynamic Logic for QASM Programs ::* Carlos Tavares, INESC TEC	Q. Information & Q. Programming
10h45	*:: Quantum Kolmogorov Complexity of Quantum States and Correlations ::* Ricardo Faleiro, IT Lisbon	

11h00 Coffee break

Session Chair: Luís Barbosa — **INVITED TALK**

11h30 *:: Classical optimization of Quantum Algorithms* — Q. Computing

Artur García-Sáez, Postdoctoral Researcher, Barcelona Supercomputing Center

Session Chair: Luís Barbosa — **CONTRIBUTED TALKS** — Q. Computing

12h00	*:: Quantum Simulation of Diatomic Molecules: a Case Study using IBM-Q ::* Mikhail I. Vasilevskiy, INL/University of Minho
12h15	*:: Reliable characterization of IBM Q devices ::* Henrique Silvéri, IST/INL
12h30	*:: Searching through Hamiltonian Spectra with Quantum Phase Estimation ::* Pedro Cruz, INL, University of Porto

Session Chair: Luís Barbosa — **INVITED TALK**

12h45 *:: Entanglement in Space: Devices and Applications*

Antia Lamas-Linares, Speqtral Quantum Technologies

13h15 Lunch break — Networking Opportunity

Session Chair: Joaquín Rossier — **AWARDS SESSION & CLOSING REMARKS**

14h30 **Joaquín Rossier**, INL

Rui Vieira de Castro, Dean, University of Minho

AFTERNOON PARALLEL SESSIONS

Session Chair: Luís Barbosa and Joaquín Rossier

HANDS-ON QUANTUM COMPUTING*

15h00 **Afonso Rodrigues,** CEiiA / University of Minho

Ana Neri, University of Minho

Bruno Murta, INL

imit of 30 participants upon confirmation by the organization.

Session Chair: Elisabeth Nilsson and Sandra Maya

COMMUNICATION SYMPOSIUM

WHY SCIENCE COMMUNICATION MATTERS?

15h00 **Elisabeth Nilsson,** Learning Organization Developer, INL

INVITED TALK

15h15 *:: Research Blogging: a Quantum Leap in Science Communication*

Francisco Villatoro, Associate Professor, Department of Computing Science and Language, Universtity of Málaga

INVITED TALK

16h00 *:: Painting the Unpaintable*

Enrique Sahagún, Scixel.es

Keynote Speakers

:: FRANK KOPPENS

ICFO

Prof. Frank Koppens obtained his PhD in Experimental Physics at Delft University, at the Kavli Institute of Nanoscience, The Netherlands.
Koppens is a group leader at the Institute of Photonic Sciences (ICFO). The quantum nano-optoelectronics group of Prof. Koppens focuses on both science and technology of novel two-dimensional materials and quantum materials. Frank is vice-chairman of the executive board of the graphene flagship program, a 1000 million euro project for 10 years. Prof. Koppens holds a GSMA Chair with activities related to the Mobile World Congress. He has received five ERC awards: the ERC starting grant, the ERC consolidator grant, and three ERC proof-of-concept grants.
Other awards include the Christiaan Hugyensprijs 2012, the national award for research in Spain, and the IUPAP young scientist prize in optics. In total, Koppens has published more than 70 refereed papers (H-index above 47), with more than 35 in Science and Nature family journals.

:: SAMSON ABRAMSKY

University of Oxford

Samson Abramsky is a Professor of Computing and a Fellow of Wolfson College, Oxford University. He holds MA degrees from Cambridge and Oxford, and a Ph.D. from the University of London.
During his career, he has won few awards including the LICS Test-of-Time, BCS Lovelace Medal and Alonzo Church Award.
More recently, Samson has been working on high-level methods for quantum computation and information.
He introduced categorical quantum mechanics with Bob Coecke, the sheaf-theoretic approach to contextuality and non-locality with Adam Brandenburger and has contributed extensively to developing a structural theory of contextuality and its applications.
Abramsky's current work is focusing on contextuality as a resource for quantum advantage. Topics include quantifying contextuality and a resource theory for contextuality, and connections with non-local games giving rise to a quantum monad on relational structures. This is ongoing work, with several collaborators.

:: CHUN NING (JEANIE) LAU

UC Riverside

Chun Ning (Jeanie) Lau is a Professor in the Department of Physics at The Ohio State University. She received her BA degree in Physics from the University of Chicago in 1994, and PhD in Physics from Harvard in 2001.
She was a Research Associate at Hewlett Packard Labs in Palo Alto from 2002 to 2004, before joining the University of California, Riverside in 2004 as an assistant professor. She was promoted to Associate Professor in 2009 and a Full Professor in 2012. Starting January 2017 she moved to Ohio State University.
Lau was the recipient of the NSF CAREER award and the PECASE award in 2008.
Her research focuses on Electronic, Thermal and Mechanical Properties of nanoscale systems, in particular, graphene and other two-dimensional systems.

Invited Speakers

:: ANTIA LAMAS-LINATES

Speqtral Quantum Technologies

Antia Lamas-Linares is quantum information scientist specializing in optical implementations of quantum technologies. She received her undergraduate degree in physics from the Universidade de Santiago, and then finished the master's degree in Applied Optics from Imperial College London. She obtained her doctoral degree at the University of Oxford in 2003 for experimental work in quantum optics.

Later, Lamas-Linares started her research group at the National University of Singapore, where she was one of the founding PIs of the Centre for Quantum Technologies where she did work in entanglement-based Quantum Key Distribution, foundations of physics, quantum hacking and spectro-temporal properties of entanglement sources.

Since 2019 she is part of SpeQtral, a company dedicated to space-based quantum communications, where she is Chief Quantum Scientist.

:: JUAN JOSÉ GARCÍA RIPOLL

Institute of Fundamental Physics, CSIC

Juan José García Ripoll finished his PhD in Optics at Universidad Complutense de Madrid, while working at Universidad de Castilla La Mancha on Bose-Einstein condensates and nonlinear Optics. He then moved to Munich with Ignacio Cirac, where he developed some key contributions in the fields of trapped ion quantum computing and help start the field of quantum simulation with ultra-cold atoms. Juanjo García Ripoll presently leads the Quantum Information and Foundations Group at the Institute of Fundamental Physics, in the Spanish Research Council. He is also the coordinator of the CSIC Platform on Quantum Technologies and of the Spanish Network on Quantum Infor-mation and Quantum Technologies.

:: LUCAS THIEL

University of Basel

Lucas Thiel is currently a Postdoctoral researcher at the University of Basel, Switzer-land, where he completed his PhD in Experimental Physics with the topic: "Low-Temperature Magnetic Sensing using a Color Center in Diamond" (2014-2019).

Thiel spent from 2013 to 2014 at Harvard University, Cambridge, USA. Before, between 2011 and early 2014, he got his Master of Science in Physics from the University of Basel. In 2011, Lucas Thiel received his Bachelor of Science in Nanosci-ence from the University of Basel.

Invited Speakers

:: UGO DAL LAGO

University of Bologna

Ugo Dal Lago is Associate Professor at the University of Bologna since 2015 and a faculty member of the Computer Science Lab at the same institution since 2006. Before that, he has been a Marie-Curie Fellow at Université Denis-Diderot in Paris. He has been involved in many international research projects and co-authored more than 80 publications which appeared in international journals and conference proceedings. He is the winner of the prize for the best Italian doctoral thesis in theoretical computer science (2006), of the Kleene Award (2006) and the prize for the best young researcher in theoretical computer science (2015). His research interests are in programming language semantics, probabilistic and quantum computation, and logic in computer science. He is the principal investigator of the ERC consolidator grant “DIAPASoN”.

:: ARTUR GARCIA-SAEZ

Barcelona Supercomputing Center

Artur Garcia-Saez works at Barcelona Supercomputing Center. He holds a PhD from the Institute of Photonic Sciences (ICFO).

His research focuses on optimization methods for Quantum Algorithms, Quantum Annealing, and Machine Learning Techniques for Quantum Control.

Artur has worked at Universitat de Barcelona and the Yang Institute of Theoretical Physics. His previous researches include Quantum Information tools for the simulation of Condensed Matter systems.

:: JOACHIM VON ZANTHIER

University of Erlangen

Joachim von Zanthier is an Associate Professor and the Leader of the working group “Quan-tum Optics and Quantum Information” of the Institute of Optics, Information, and Photonics at Friedrich-Alexander University Erlangen-Nürnber, Germany.

Zanthier received his PhD at the Institute of Optics, University of Paris VI, France; and his undergraduate and graduate studies of Physics at Ludwig-Maximilians-Universität, Germany. Joachim's research interests are focused on the state engineering of light and matter, non-classical spatial and temporal photon correlations, multi-photon-interfaces at optical and x-ray wavelengths, collective light emission and quantum imaging.

Invited Speakers

:: ENRIQUE SAHAGÚN
Scixel

Enrique Sahagún studied Physics in Madrid and got his PhD in Theoretical Condensed Matter Physics at the Universidad Autónoma de Madrid. His research during these years covered the understanding of the dynamics of AFM in dissipative environments. Before that, he completed a Master's in Biophysics.
Being deeply interested in digital graphics since the late nineties, in 2012 he funded Scixel, a small project devoted to the improvement of scientific communication through the creation of graphical products: pictures, animations, documentaries, plots. Today, Scixel develops visual projects for researchers all over the world.
In particular, he has worked for TuDelft (the Netherlands), Basel University (Switzerland), NIMS (Japan) in quantum related projects.

:: FABIO SCIARRINO
University Sapienza

Fabio Sciarrino is a Full Professor at the Physics Department of the University of Rome La Sapienza and Senior Research Fellow at the International School for Advanced Studies Sapienza, SSAS. He is the Principal Investigator of the Quantum Information Lab, Department of Physics, Sapienza University of Rome.
His main expertise is experimental quantum optics, computation and quantum information, and foundations of quantum mechanics.
In recent years his research activity has focused on the implementation of quantum information protocols via integrated photonic circuits, with particular interest for Boson Sampling, a non-universal computational model with promising characteristics to achieve the quantum supremacy regime.

:: FRANCISCO R. VILLATORO
University of Málaga

Francisco R. Villatoro received the MS degree in Computer Science from the Universidad de Málaga (Spain), in 1992, the MS degree in Physics from the Universidad Nacional de Edu-cación a Distancia (Spain), in 1993, and the PhD degree in Mathematics from the Univer-sidad de Málaga, in 1998.
Since 1996, he has been with the Department of Lenguajes y Ciencias de la Computación, Universidad de Málaga, where he was an Assistant Professor and, currently, an Associate Professor.
His research interests are in Computational Science and Applied Mathematics. He is a research blogger from 2008, with an intense activity as a Science Communicator in Spain.

Invited Speakers

:: JORGE QUEREDA
University of Salamanca

Jorge Quereda is a Postdoctoral Researcher with seven years of experience in the field of two-dimensional materials and devices.
In June 2019 Jorge joined the nanotechnology group at the University of Salamanca, where he currently works as a postdoc researcher.
Quereda published 12 scientific articles in peer-reviewed, high impact journals including Na-ture Communications, Nano Letters or 2D Materials. His scientific articles accumulate more than 470 citations, with an H-index of 9.
His work has been presented as well in seminars and scientific conferences both at a national and international level, in the form of invited talks, oral communications, and scientific posters.

:: RAMÓN AGUADO
ICMM-CSIC

Ramón Aguado, with a PhD in Theoretical Physics, is a Senior Scientist of the Spanish Research Council (CSIC) working at the Materials Science Institute of Madrid (ICMM), where he leads the "Theory of Quantum Materials and Solid State Quantum Technologies" group. His main research interests are in condensed matter theory with a focus on quantum transport, strong correlations, and topological materials.
During the last few years, his activity has focused on hybrid superconductor-semiconductor systems where interesting physical effects such as Kondo, BCS superconducting pairing or magnetic states compete. This fundamental interest, together with the possibility of obtaining Majorana bound states in topological superconductors based on such systems, makes hybrids one of the more exciting topics in modern condensed matter physics.
Before becoming a permanent scientist at CSIC, he was a postdoctoral researcher at the Physics Department at Rutgers State University of New Jersey and at the Quantum Transport group at Delft University of Technology. Since 2018 he coordinates the theory work package of the Quantum Technologies Platform at CSIC.

:: ROSER VALENTÍ
University of Frankfurt

Roser Valenti is a Professor of Physics at Goethe University Frankfurt. She received her PhD degree in Theoretical Physics at the University of Barcelona. Before joining Frankfurt, she was postdoctoral Fulbright fellow at the University of Florida at Gainesville, Habilitati-on researcher at the University of Dortmund and Heisenberg fellow at the University of Saarland, Germany.
Since 2016 she is an APS Fellow, and from 2009 to 2012 she was vice-president of the Goethe University Frankfurt. Her field of research is the microscopic modeling of correlated materials such as unconventional superconductors, frustrated magnets, and systems with topologically non-trivial states via a combination of first-principles-based methods and many-body numerical techniques.

Invited Speakers

:: LEE ROSEMA

University of Vienna

Lee Rozema is a Templeton Independent Research Fellow working at the University of Vienna in the Quantum Information Science and Quantum Computing group with Prof. Philip Walther.
In 2008 he received his Bachelor of Science in Physics and Computer Science with first-class standing from Brock University in Canada.
He completed his Doctorate in 2014 with Prof. Aephraim Steinberg at the University of Toronto. His doctoral research focused on a broad array of topics in experimental quantum optics and quantum information, from quantum-enhanced precision measurement to more fundamental topics, such as weak measurement and interpretations of quantum mechanics.
His current research topics include quantum foundations, photonic quantum computing, and the investigation of novel optical non-linearities.

:: TATIANA G. RAPPOPORT

University of Rio de Janeiro

Tatiana G. Rappoport is an Associate Professor at the Physics Institute of the Federal University of Rio de Janeiro, and she is currently visiting Minho University.
As a Condensed Matter theoretician, her research focuses on Spin, Charge and Optical Properties of Novel two-dimensional Materials, Spintronics and Topological States of Matter.

:: ASGER MORTENSEN

SDU

Mortensen is a full professor & VILLUM Investigator in the Center for Nano Optics and a Chair of Technical Science in the Danish Institute for Advanced Study, both at the University of Southern Denmark. Previously, he held a full professorship (faculty since 2004) at the Technical University of Denmark, from where he was also awarded his academic degrees [Dr. Techn. (2006), PhD (2001), MSc (1998)]. He is a fellow of APS, OSA, SPIE, IOP, and EurASc.
His current research in quantum and nonlocal electrodynamics is supported by a personal grant from the VILLUM Foundation [5+ MEUR].

BRAGA, a lovely city

Braga is a lovely city, one of the oldest in the country, and is teeming with young people who study at its University.

Built more than 2,000 years ago, "Bracara Augusta" was founded by Roman Emperor Augustus. It was located on one of the main Roman roads in the Iberian Peninsula, it was the administrative seat of the Empire, and later given the status of capital of the Roman province of Gallaecia, present-day Galicia, by Emperor Caracalla. The Braga Diocese is the oldest in Portugal and, in the Middle Ages, the city even competed with Santiago de Compostela in power and importance. One of the "Caminos de Santiago" passed through here when this pilgrimage cult grew after the Christian reconquest and the foundation of Portugal.

Braga's Cathedral is also the oldest in the country and was built in the 12th century by the parents of Portugal's first King, D. Henrique, and D. Teresa, who are buried there. Braga is to this day one of the country's main religious centres, having the Holy Week celebrations and the São João festival as the highlights in its liturgical and tourist calendar.

Besides the Tesouro-Museu da Sé (Cathedral Treasure Museum), it is worth visiting the Biscainhos Museum, housed in a Baroque palace, a landmark period in the history of Braga, and the D. Diogo de Sousa Archaeological Museum, since the city also abounds in remains from the Roman era. We suggest a leisurely stroll around the historic centre to visit some of its many churches, admire the houses and historical buildings, such as **Palácio do Raio, Theatro Circo, or Arco da Porta Nova,** and to have a coffee at the emblematic Brasileira with a view of the busy Avenida Central. But Braga is also considered the youngest city in Portugal and, from its contemporary landmarks, the Braga Municipal Stadium stands out, designed by Souto Moura, one of the most prestigious Portuguese architects and a winner of the Pritzker Prize.

The **Theatro Circo** was promoted in 1906 by a group of people from Braga, led by Artur José Soares, José António Veloso, and Cândido Martins. To that date, the city only had the small Teatro São Geraldo. In 1911, the project began to take shape by the hand of the architect João de Moura Coutinho and on April 21, 1915, Theatro Circo was opened, coinciding with a period of great economic and social development in Braga.
Over the decades, the space undergone profound works of rehabilitation, aimed at the conversion of Theatro Circo into a large cultural complex, equipped with the most updated and complete scenic and sound technology, able to meet the needs of contemporary art in its many dimensions.

Praça da República
More info: https://visitbraga.travel/braga

Catedral da Sé de Braga
More info: braga.360portugal.com

Theatro Circo
More info: www.theatrocirco.com/en

Bom Jesus de Braga
More info: www.youtube.com (Aerial view in 4k)
https://bragacool.com/visitar/bom-jesus-monte
https://www.travelingwithaga.com/how-to-visit-bom-jesus

Every visitor to Braga must see the **Bom Jesus Sanctuary,** a city icon, with its monumental stair¬case, declared World Heritage by UNESCO in 2019. Amid an expanse of greenery, it offers an excellent panoramic view of the city, as do two other churches nearby: Nossa Senhora do Sameiro Sanctuary, an important place of Marian worship, and Santa Maria da Falperra Church.
Bom Jesus is considered one of the most beautiful sanctuaries in Portugal and it's a reference of Baroque art in Portugal, with its history dating back to the 14th century.
To get there, you can climb the famous staircase to the neoclassical church, with 581 steps, surrounded by magnificent gardens and hotels. Alternatively, you can use the elevator that takes you to the top of the staircase. This elevator, operating since 1882, is unique in the Iberian Peninsula and the oldest in the world still active. The lift is moved by water, by counterweight, with two cabins, which are connected by a cable. The way this elevator works makes it one of the most extraordinary engineering pieces in Portugal.

Moreover, it's also possible to take the car to the top and have a picnic in the magnificent gardens of Bom Jesus and thus enjoy the fresh air of nature and breathtaking scenery. The sunset seen from here gives a whole new sense to the concept of "golden hour".

Over the last few years, the University of Minho and the quality of contemporary architecture have instilled an atmosphere of youthful vibrancy which has brought this ancient city to a level of unexpected modernity.
All these attributes were paramount for Braga to be considered the **Second Best Destination in Europe in 2019** in the contest promoted by **"European Best Destinations".**

Garden of Santa Bárbara
More info: braga.360portugal.com

Here you can download a tour guide and more information about Braga:
https://visitbraga.travel/pub/media/guia/roteiro_braga.pdf

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QUANTUM SCIENCE & TECHNOLOGIES

INL, BRAGA, PORTUGAL

Outubro 22 - 24, 2019

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Versão em Português

Quantum Science & Technologies

Outubro 22-24, 2019 | **INL**, Braga (Portugal)

Conferência Internacional nanoGateway

Bem-vindos à Conferência Internacional Mission 10.000: Quantum Science & Technologies, iniciativa do projeto nanoGateway

As tecnologias da informação têm moldado a nossa civilização nas últimas quatro décadas. Determinam desde a maneira como trabalhamos, as nossas interações sociais, entretenimento, saúde, mercados financeiros, passando até pela previsão do tempo, bem como o nosso potencial para fazer investigação e inovar. As tecnologias da informação têm-se baseado em avanços de um conjunto um tanto limitado de materiais, como semicondutores, e no uso de informação clássica.

Testemunhamos agora o surgimento de novos paradigmas. Por um lado, o advento da informação quântica e as consequentes áreas de aplicação como **computação quântica, simulação quântica, sensoriamento quântico e comunicação quântica.** Por outro lado, a busca de materiais quânticos funcionais cujas propriedades quânticas coletivas podem ser aproveitadas para oferecer novas funcionalidades. Assim, após os 100 anos do nascimento da **física quântica,** a exploração de **materiais quânticos, tecnologias quânticas e informações quânticas** são das áreas de investigação de ponta mais ativas.
A Conferência Internacional de Ciência e Tecnologia Quântica, um evento patrocinado pelo projeto Interreg nanoGateway, reuniu especialistas de todo o mundo para apresentar os últimos resultados em quatro áreas: *Computação Quântica Aplicada e Simulação Quântica, Sensoriamento Quântico e Imagiologia, Materiais Quânticos para Tecnologias Quânticas e Engenharia de Software Quântico.*

A iniciativa nanoGateway

NanoGateway é um projeto que visa a implementação de uma estratégia multirregional e plano de ação para explorar o potencial da nanotecnologia no fomento do crescimento inteligente, riqueza e qualidade de vida.

O **projeto nanoGateway** é cofinanciado pelo Programa de Cooperação Interreg V-A Espanha – Portugal (POCTEP) e liderado pelo INL, envolvendo as Agências de Desenvolvimento Regional da área abrangida.

REGIÕES INTERREG-POCTEP

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Alto Tâmega
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Ave
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Cávado
Douro
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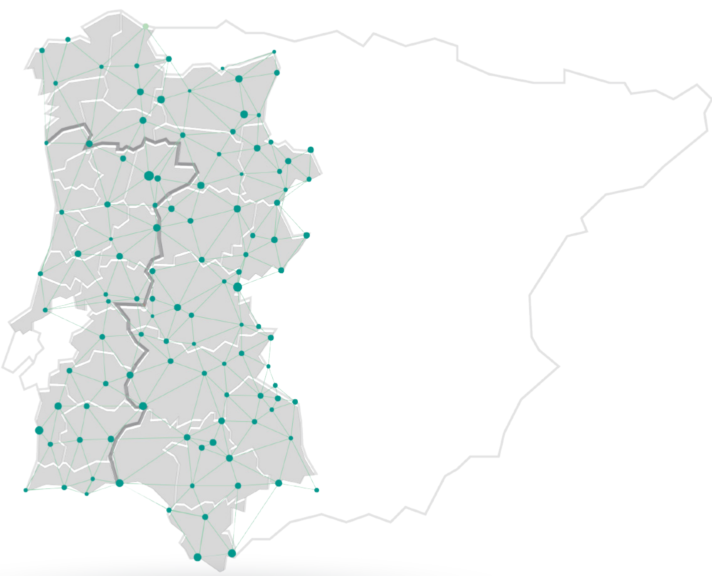
Oeste and Alentejo Litoral
Região de Aveiro
Região de Coimbra
Região de Leiria
Tâmega e Sousa
Trás-os-Montes
Viseu Dão-Lafões



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Bem-vindos à Conferência Internacional Mission 10.000: Quantum Science & Technologies

Encerrando o Ciclo de Conferências Mission 10.000, o INL recebeu o evento Mission 10.000: Quantum Science and Technologies entre os dias 22 e 24 de outubro.
Depois do sucesso da edição de 2018, esta conferência deu continuidade à iniciativa colaborativa do nanoGateway que visa encontrar respostas a desafios societais complexos. O projeto baseia o seu plano de ação no fomento do impacto da investigação em matérias de relevância social, contando, para isso, com o envolvimento de todos os atores-chave da região POCTEP.
Nos últimos anos, aconteceram vários desenvolvimentos muito importantes sob o nome de "Segunda Revolução Quântica". Esse movimento tem o potencial de tornar possíveis várias tecnologias disruptivas e as Tecnologias Quânticas têm o potencial de mudar de forma profunda vários setores económicos, que incluem comunicações seguras na Internet, logística, finanças, criação de novos medicamentos, simulação de materiais complexos, entre outros. Essas mudanças vão ter vencedores e vencidos. Por isso, é de extrema importância que organizações académicas, empresas, países e organizações transnacionais sejam capazes de traçar a respetiva Estratégia Quântica, para conseguir explorar as oportunidades criadas pela Segunda Revolução Quântica. As Tecnologias Quânticas estão diretamente ligadas à Nanotecnologia, enquanto forma de tornar tantas outras inovações possíveis, e as oportunidades que agora estamos a identificar estão também ligadas às consequências adicionais da digitalização e da globalização.
Ao longo de três dias tivemos o prazer de receber mais de 130 participantes num evento que contou com a presença de três Keynote Speakers, 16 palestrantes convidados, diversas apresentações orais e apresentações de posters.
100 anos após o nascimento da física quântica, a exploração de materiais quânticos, tecnologias quânticas e informações quânticas, tivemos a oportunidade de testemunhar o surgimento de novos paradigmas. Tivemos ainda o prazer de atribuir dois prémios ao Melhor Poster e Melhor Apresentação Oral nesta iniciativa que reuniu especialistas de todo o mundo.

Atenciosamente,

Prof. Dr Lars Montelius,
DG, INL

INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

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Oradores Principais

:: FRANK KOPPENS

ICFO

O Prof. Frank Koppens concluiu o seu doutoramento em Física Experimental na Universi-dade de Delft, no Instituto Kavli de Nanociência, Países Baixos.
Koppens é líder de grupo no Instituto de Ciências Fotónicas (ICFO). O grupo nano-optoeletrónico de quantum do Prof. Koppens centra-se na ciência e na tecnologia de novos materiais bidimensionais e quânticos.
Frank é vice-presidente do conselho executivo do principal programa de grafeno, um pro-jeto de 1.000 milhões de europeus em 10 anos. O Prof. Koppens é diretor da GSMA em atividades relacionadas com Mobile World Congress. Para além disso, recebeu cinco pré-mios ERC: a concessão inicial do ERC, a concessão do consolidador do ERC e três conces-sões de prova de conceito do ERC.
Outros prémios incluem o Christiaan Hugyensprijs 2012, o prémio nacional de pesquisa na Espanha, e o prémio de jovem cientista da IUPAP em Óptica. No total, Koppens publicou mais de 70 artigos arbitrados (índice H acima de 47), com mais de 35 em revistas de famí-lia sobre Ciência e Natureza.

:: CHUN NING (JEANIE) LAU

UC Riverside

Chun Ning (Jeanie) Lau é Professora no Departamento de Física da Universidade Es-tadual de Ohio. Concluiu a Licenciatura em Física pela Universidade de Chicago, em 1994, e o Doutoramento em Física pela Universidade de Harvard, 2001.
Foi Investigadora Associada no Hewlett Packard Labs em Palo Alto, entre 2002 e 2004, antes de afiliar-se à Universidade da Califórnia, Riverside em 2004, como Professora Assistente. Foi promovida a Professora Associada em 2009 e professora catedrática em 2012. A partir de janeiro de 2017, mudou-se para a Ohio State University. Lau recebeu o prémio NSF CAREER e o prémio PECASE em 2008. A sua pesquisa con-centra-se nas propriedades Eletrónicas, Térmicas e Mecânicas de sistemas em nanoescala, em particular grafeno e outros sistemas bidimensionais.

:: SAMSON ABRAMSKY

University of Oxford

Samson Abramsky é Professor de Computação e Membro do Wolfson College, Universidade de Oxford. Possui um Mestrado por Cambridge e Oxford, e um Doutoramento pela Universidade de Londres.
Ao longo da sua carreira, ganhou alguns prémios, incluíndo o LICS Test-of-Time, a Medalha BCS Lovelace e o Alonzo Church Award.
Mais recentemente, Samson tem trabalhado em métodos de alto nível para computação e informação quânticas. Samson introduziu a mecânica quântica categórica com Bob Coecke, a abordagem teórica da polia da contextualidade e da não localidade com Adam Brandenburger e contribuiu extensivamente para o desenvolvimento de uma teoria estrutural da contextualidade e das suas aplicações.
O trabalho atual de Abramsky foca-se na contextualidade como um recurso para a vantagem quântica. Os seus tópicos incluem quantificar a contextualidade e uma teoria de recursos para contextualidade e conexões com jogos não locais, dando origem a uma mônada quântica nas estruturas relacionais. Este é um trabalho contínuo, com vários colaboradores.

Oradores Convidados

:: ANTIA LAMAS-LINATES
Speqtral Quantum Technologies

Antia Lamas-Linares é investigadora em informação quântica, especializada em implementações óticas de tecnologias quânticas. Concluiu licenciatura em Física pela Universidade de Santiago, e, posteriormente, o mestrado em Ótica Aplicada pelo Imperial College de Londres. Obteve o grau de doutoramento na Universidade de Oxford em 2003 por trabalhos experimentais em ótica quântica.
Mais tarde, Lamas-Linares iniciou o seu próprio grupo de investigação na Universidade Nacional de Singapura, onde foi uma das Investigadoras Principais fundadoras do Centro de Tecnologias Quânticas, trabalhando em distribuição de chaves quânticas baseada em entrelaçamento, fundamentos da física, hacking quântico e propriedades espectro-temporais de fontes de entrelaçamento.

:: JUAN JOSÉ GARCÍA RIPOLL
Institute of Fundamental Physics, CSIC

Juan José García Ripoll concluiu o seu doutoramento em Ótica na Universidade Complutense de Madrid, enquanto trabalhava na Universidade Castilla La Mancha em Bose-Einstein condensados e ótica não linear. Mudou-se depois para Munique com Ignacio Cirac, onde desenvolveu con-tribuições importantes nos campos de computação quântica de iões e ajudou a iniciar o campo da simulação quântica com átomos ultrafrios. Juanjo García Ripoll lidera atualmente o Quantum Infor-mation and Foundations Group do Instituto de Física Fundamental, no Conselho Nacional de Inves-tigação Espanhol (CSIC). É ainda coordenador do CSIC Platform on Quantum Technologies e do Span-ish Network on Quantum Information and Quantum Technologies.

:: LUCAS THIEL
University of Basel

Lucas Thiel é atualmente investigador de pós-doutoramento na Universidade de Ba-sileia, Suíça, onde concluiu o seu doutoramento em Física Experimental com o tópico: "Sensoriamento magnético de baixa temperatura usando o centro de cor do diaman-te" (2014-2019).

Entre 2013 e 2014, Thiel passou pela Universidade de Harvard, Cambridge, EUA. Anteriormente, entre 2011 e início de 2014, concluiu o Mestrado em Física pela Uni-versidade de Basileia, instituto onde tinha já concluido a licenciatura em Nanociência.

Oradores Convidados

:: UGO DAL LAGO

University of Bologna

Ugo Dal Lago é professor associado da Universidade de Bolonha desde 2015 e membro do corpo docente do Laboratório de Ciência da Computação da mesma instituição desde 2006. Antes disso, foi bolseiro Marie-Curie na Université Denis-Diderot em Paris. Esteve envolvido em diversos projetos internacionais de investigação e é coautor de mais de 80 publicações que figuram em revistas internacionais e atas de conferências. É o vencedor do prémio de melhor tese de doutoramento italiana em ciência da computação teórica (2006), do Kleene Award (2006) e do prémio de melhor jovem investigador em ciência da computação teórica (2015). Os seus interesses de investigação passam pela semântica da linguagem de programação, probabilística e computação quântica e lógica em ciência da computação. Dal Lago é o investigador principal do projeto "DIAPASoN", financiado pela prestigiada bolsa ERC para o nível Consolidador.

:: JOACHIM VON ZANTHIER

University of Erlangen

Joachim von Zanthier é Professor Associado e Líder do Grupo de Trabalho "Óptica Quântica e Informação Quântica" do Instituto de Óptica, Informação e Fotónica da Universidade Friedrich-Alexander Erlangen-Nürnber, Alemanha. Zanthier concluiu o seu Doutoramento no Instituto de Óptica na Universidade de Paris VI, França; e a sua Graduação e Pós-graduação em Física na Ludwig-Maximilians-Universität, Alemanha.

Os seus interesses de investigação focam-se na Engenharia de estado da luz e da matéria, correlações espaciais e temporais não clássicas de fótons, interfaces de múltiplos fótons nos comprimentos de onda ópticos e de raios-X, emissão coletiva de luz e imagem quântica.

:: ARTUR GARCIA-SAEZ

Barcelona Supercomputing Center

Artur Garcia-Saez trabalha no Centro de Supercomputação de Barcelona. Concluiu o seu Doutoramento no Instituto de Ciências Fotónicas (ICFO).

A sua pesquisa centra-se em Métodos de Optimização para Algoritmos Quânticos, Recozimento Quântico e Técnicas de Aprendizagem para Máquinas para Controlo Quântico.

Artur trabalhou na Universidade de Barcelona e no Instituto Yang de Física Teórica. Pesquisas anteriores realizadas por si incluem ferramentas de informação quântica para a simulação de sistemas de matéria condensada.

Quantum Science & Technologies

Outubro 22-24, 2019 | **INL**, Braga (Portugal)

Conferência Internacional nanoGateway

Oradores Convidados

:: ENRIQUE SAHAGÚN

Scixel

Enrique Sahagún estudou Física em Madrid, e fez o seu doutoramento em Física Teórica da Matéria Condensada na Universidade Autónoma de Madrid. Nos últimos anos, as suas pesquisas contemplam o entendimento da dinâmica do AFM em ambientes dissipativos. Antes disso, Enrique completou o Mestrado em Biofísica.
Interessado profundamente em gráficos digitais desde o final dos anos 90, em 2012 fundou o Scixel, um pequeno projeto dedicado à melhoria da comunicação científica através da criação de produtos gráficos: fotos, animações, documentários, enredos. Hoje em dia, o Scixel desenvolve projetos visuais para pesquisadores em todo o mundo. Particularmente, Sahagún trabalhou em TuDelft (Holanda), Universidade de Basileia (Suíça), NIMS (Japão) em Projetos relacionados com a Quântica.

:: FABIO SCIARRINO

University Sapienza

Fabio Sciarrino é Professor Catedrático do Departamento de Física da Universidade de Roma La Sapienza e Investigador Sénior da Escola Internacional de Estudos Avançados de Sapienza, SSAS. É o principal Investigador do Quantum Information Lab, Departamento de Física, Universidade Sapienza de Roma.
As suas principais áreas de atuação são a óptica quântica experimental, a computação e informação quântica e os fundamentos da mecânica quântica.
Nos últimos anos, a sua atividade de pesquisa centrou-se na implementação de protocolos de informação quântica por meio de circuitos fotónicos integrados, com particular interesse pelo Boson Sampling, um modelo computacional não universal com características promissoras para alcançar o regime de supremacia quântica.

:: FRANCISCO R. VILLATORO

University of Málaga

A formação académica de Francisco R. Villatoro contempla o Mestrado em Ciências da Computação pela Universidade de Málaga (Espanha), em 1992; o Mestrado em Física pela Universidad Nacional de Educación a Distancia (Espanha), em 1993; e o Doutoramento em Matemática pela Universidade de Málaga, em 1998.
Desde 1996, Francisco trabalha no Departamento de Lenguajes y Ciencias de la Com-putación da Universidad de Málaga, onde foi professor assistente e é atualmente Professor Associado.
Os seus interesses de pesquisa centram-se nas Ciências da Computação e a Matemática Aplicada. Ele é Research Blogger desde 2008, com uma atividade notória como Comunica-dor de Ciência em Espanha.

Oradores Convidados

:: JORGE QUEREDA

University of Salamanca

Jorge Quereda é um Investigador de Doutoramento com sete anos de experiência no campo de materiais e dispositivos bidimensionais. Em junho de 2019, Jorge juntou-se ao grupo de nanotecnologia da Universidade de Salamanca, onde atualmente trabalha como investigador.
Quereda publicou 12 artigos científicos em revistas especializadas de referência, incluindo Na-ture Communications, Nano Letters ou 2D Materials. Os seus artigos científicos detém mais de 470 citações, com um índice H de 9.
O seu trabalho foi também apresentado em seminários e conferências científicas a nível nacional e internacional, em forma de palestras para as quais foi convidado, apresentações orais e pósteres científicos.

:: RAMÓN AGUADO

ICMM-CSIC

Ramón Aguado, doutorado em Física Teórica, é Investigador Sénior do Conselho de Pesquisa Espanhol (CSIC) e trabalha no Instituto de Ciência de Materiais de Madrid (ICMM), onde lidera o grupo "Teoria de materiais quânticos e tecnologias quânticas de estado sólido". Os seus principais interesses de investigação debruçam-se sobre a teoria da matéria condensada, com foco no transporte quântico, fortes correlações e materiais topológicos.
Nos últimos anos, a sua atividade tem-se concentrado em sistemas supercondutores-semicondutores híbridos, onde efeitos físicos interessantes como Kondo, transição supercondutora BCS ou estados magnéticos competem. Este interesse fundamental, juntamente com a possibilidade de obter estados ligados a Majorana em supercondutores topológicos baseados em tais sistemas, torna os híbridos num dos tópicos mais interessantes da física moderna da matéria condensada. Antes de se tornar cientista na CSIC, fez a sua pesquisa de doutoramento no Departamento de Física da Universidade Estadual de Rutgers de Nova Jersey, e no grupo de Transporte Quântico da Universidade de Tecnologia de Delft. Desde 2018, coordena o programa de trabalho teórico da Quantum Technologies Platform no CSIC.

:: ROSER VALENTÍ

University of Frankfurt

Roser Valenti é Professora de Física na Universidade Goethe de Frankfurt. Concluiu o seu Doutoramento em Física Teórica na Universidade de Barcelona. Antes de se matricular em Frankfurt, obteve uma bolsa de investigação Fulbright em Pós-doutoramento na Universi-dade da Flórida, em Gainesville; foi Investigadora de Habilitação na Universidade de Dortmund e recebeu uma bolsa de investigação Heisenberg na Universidade de Saarland, Alemanha.
Desde 2016 é bolseira da APS, e entre 2009 e 2012 foi vice-presidente da Universidade Goethe de Frankfurt. O seu campo de pesquisa foca-se na modelagem microscópica de materiais correlatos como supercondutores não convencionais, ímanes e sistemas com topologia não trivial, através de uma combinação de métodos baseados nos primeiros princípios e técnicas numéricas de muitos corpos.

Oradores Convidados

:: LEE ROSEMA

University of Vienna

Lee Rozema trabalha como Templeton Independent Research Fellow na Universidade de Viena, no grupo de Ciência da Informação Quântica e Computação Quântica com o Prof. Philip Walther.
Em 2008 licenciou-se em Ciência na Física e na Ciência da Computação, sendo um dos melhores alunos na Universidade Brock, no Canadá.
Concluiu o seu Doutoramento em 2014 com o professor Aephraim Steinberg na Univer-sidade de Toronto. A sua pesquisa de Doutoramento centrou-se numa vasta gama de tópicos como a óptica quântica experimental, a informação quântica, desde medições de precisão com aprimoramento quântico até tópicos mais fundamentais, como medições fracas e interpretações da mecânica quântica. Os seus temas de pesquisa atuais incluem fundamentos quânticos, computação quântica fotónica e investigação de novas ópticas não lineares.

:: TATIANA G. RAPPOPORT

University of Rio de Janeiro

Tatiana G. Rappoport é Professora Associada do Instituto de Física da Universidade Federal do Rio de Janeiro e, atualmente é convidada da Universidade do Minho.
Como especialista em Matéria Condensada, a sua investigação foca-se nas Propriedades de Rotação, de Carga e Ópticas de Novos Materiais Bidimensionais, Spintrónica e Estados Topológicos da Matéria.

:: ASGER MORTENSEN

SDU

Mortensen é professor catedrático e investigador VILLUM no Centro de Nano Ótica e ainda Presidente de Ciência Técnica no Instituto Dinamarquês para Estudos Avançados, ambos na University of Southern Denmark.
Anteriormente, foi professor titular (corpo docente desde 2004) na Universidade Técnica da Dinamarca, instituto onde também se formou [Dr. Techn. (2006), PhD (2001), MSc (1998)]. É membro da APS, OSA, SPIE, IOP, e EurASc.
A sua atual investigação em eletrodinâmica quântica e não-local é financiada por uma bolsa privada da Fundação VILLUM [5+ MEUR].

BRAGA, uma cidade encantadora

Braga é uma cidade animada, sendo uma das mais antigas de Portugal, e está repleta de jovens que estudam na Universidade aqui instalada.

Construída há mais de 2.000 anos, "Bracara Augusta" foi fundada pelo imperador romano Augusto. Estava localizada numa das principais estradas romanas da Península Ibérica, era a sede administrativa do Império e, posteriormente, recebeu o estatuto de capital da província romana de Gallaecia, atual Galiza, pelo imperador Caracalla. A diocese de Braga é a mais antiga de Portugal. Na Idade Média, a cidade competia com Santiago de Compostela em poder e importância. Um dos "Caminos de Santiago" passou por aqui quando este popular culto de peregrinação cresceu após a Reconquista cristã e a fundação de Portugal.

A **Catedral de Braga** é também a mais antiga do país e foi construída no século XII pelos pais do primeiro rei de Portugal, D. Henrique e D. Teresa, que estão ali sepultados. Braga é, ainda hoje, um dos principais centros religiosos do País, tendo as comemorações da Semana Santa e as Festas Populares de São João como destaques no calendário litúrgico e turístico.

Além do Tesouro-Museu da Sé, vale a pena visitar o Museu dos Biscainhos, instalado num palácio Barroco, um período marcante na história de Braga, bem como o Museu Arqueológico D. Diogo de Sousa, já que, na cidade, também abundam os restos da era romana. Sugerimos um passeio ao redor do centro histórico para visitar algumas das muitas igrejas, admirar as casas e edifícios históricos, como o Palácio do Raio, o Theatro Circo ou o Arco da Porta Nova, e tomar um café na emblemática Brasileira com vista para a movimentada Avenida Central. No entanto, Braga também é considerada a cidade mais jovem de Portugal e, dos seus marcos contemporâneos, destaca-se o Estádio Municipal de Braga, projetado por Souto Moura, um dos arquitetos portugueses mais prestigiados e vencedor do Prémio Pritzker.

O **Theatro Circo** foi promovido em 1906 por um grupo de pessoas de bracarenses, liderado por Artur José Soares, José António Veloso e Cândido Martins. Até essa data, a cidade tinha apenas o pequeno Teatro São Geraldo. Em 1911, o projeto começou a ganhar forma pelas mãos do arquiteto João de Moura Coutinho e a 21 de abril de 1915 foi inaugurado o Theatro Circo, coincidindo com um período de grande desenvolvimento económico e social em Braga. Ao longo das décadas, o espaço passou por profundas obras de reabilitação, para converter o Theatro Circo num grande complexo cultural, equipado com a mais moderna e completa tecnologia cénica e sonora, capaz de atender às necessidades da arte contemporânea nas mais diversas dimensões.

Praça da República
Mais info: https://visitbraga.travel/braga

Catedral da Sé de Braga
Mais info: braga.360portugal.com

Theatro Circo
Mais info: www.theatrocirco.com/en

Todo o visitante de Braga deve ir ao **Santuário do Bom Jesus,** um ícone da cidade, com sua escadaria monumental, declarado Património Mundial pela UNESCO em 2019. Situado no meio de uma extensa área de vegetação, oferece uma excelente vista panorâmica da cidade, assim como outras duas igrejas próximas: o Santuário da Nossa Senhora do Sameiro, um importante local de culto mariano, e a Igreja de Santa Maria da Falperra.

O **Bom Jesus** é considerado um dos santuários mais bonitos de Portugal e uma referência da arte barroca no País, com uma história que remonta ao século XIV.

Para chegar ao topo, pode usar-se a famosa escadaria que leva à igreja neoclássica, com 581 degraus, cercada por jardins e hotéis magníficos. Como alternativa, pode optar-se pelo elevador que sobre até ao topo da escada. Este elevador, em operação desde 1882, é único na Península Ibérica e o mais antigo do mundo ainda ativo. O elevador é movido por contrapeso de água, com duas cabines, que são ligadas por um cabo. O funcionamento original deste elevador faz dele uma das peças de engenharia mais extraordinárias de Portugal.

Além disso, também é possível levar o carro até o topo e fazer um piquenique nos magníficos jardins de Bom Jesus e, assim, desfrutar do ar fresco da natureza e de um cenário de tirar o fôlego. O pôr do sol visto daqui dá um novo sentido ao conceito de "hora de ouro".

Nos últimos anos, a Universidade do Minho e a qualidade da arquitetura contemporânea criaram uma atmosfera de vibração juvenil que levou esta cidade antiga a um nível inesperado de modernidade.

Todos esses atributos foram essenciais para Braga ser considerada o **Segundo Melhor Destino da Europa em 2019** no concurso promovido pela "**European Best Destinations**".

Bom Jesus de Braga

Mais info: www.youtube.com (Aerial view in 4k)

https://bragacool.com/visitar/bom-jesus-monte

https://www.travelingwithaga.com/how-to-visit-bom-jesus

Jardim de Santa Bárbara

More info: braga.360portugal.com

Aqui você pode baixar um guia de turismo e mais informações sobre Braga:
https://visitbraga.travel/pub/media/guia/roteiro_braga.pdf

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nano GATEWAY

mission 10 000 conference

QUANTUM SCIENCE & TECHNOLOGIES

INL, BRAGA, PORTUGAL

22 a 24 de Octubre, 2019

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Versión en Español

Quantum Science & Technologies

22 a 24 de Octubre, 2019 | **INL**, Braga (Portugal)

nanoGateway Conferencia Internacional

Bienvenidos a la Conferencia Internacional Mission 10.000: Quantum Science & Technologies, una iniciativa de nanoGateway

Las tecnologías de la información han dado forma a nuestra civilización durante las últimas cuatro décadas. Determinan la forma en que trabajamos, nuestras interacciones sociales, entretenimiento, salud, mercados financieros, pronóstico del tiempo, así como nuestro potencial para investigar e innovar. Las tecnologías de la información se han basado tanto en avances de un conjunto de materiales algo limitado, como semiconductores, como en el uso de información clásica.

Ahora somos testigos del surgimiento de nuevos paradigmas. Por un lado, el advenimiento de la **información cuántica** y las áreas de aplicación consecuentes, como la **computación cuántica,** la **simulación cuántica,** la **detección cuántica** y la **comunicación cuántica.** Por otro lado, la búsqueda de materiales cuánticos funcionales cuyas propiedades cuánticas colectivas se puedan aprovechar para ofrecer nuevas funcionalidades. Después del centenario del nacimiento de la física cuántica, la exploración de materiales cuánticos, tecnologías cuánticas e información cuántica se encuentran entre las áreas de investigación de vanguardia más activas.

La Conferencia Internacional sobre Ciencia y Tecnología Cuántica, un evento patrocinado por el proyecto Interreg nanoGateway, reunió a expertos de todo el mundo para discutir los últimos descubrimientos en cuatro áreas: *Computación Cuántica Aplicada y Simulación Cuántica, Detección e Imagen Cuántica, Materiales Cuánticos para Tecnologías Cuánticas y Ingeniería de software cuántico.*

La iniciativa nanoGateway

NanoGateway es un proyecto orientado a implementar una estrategia plurirregional y un plan de acción para desbloquear el potencial de la nanotecnología para generar crecimiento inteligente, riqueza y bienestar.

El proyecto **nanoGateway,** cofinanciado por el Programa de Cooperación Interreg V-A España-Portugal (POCTEP), está liderado por el INL y cuenta con la participación de las Agencias de Desarrollo Regional POCTEP.

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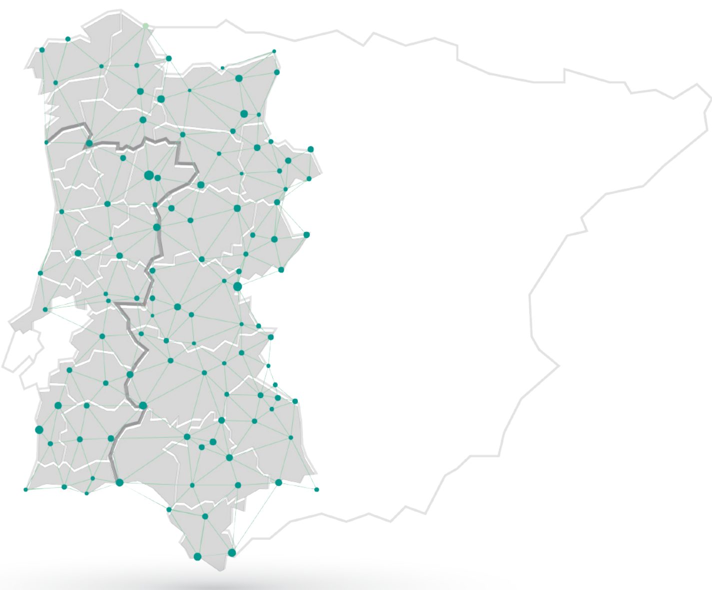

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mission 10 000 conference

Bienvenidos a la Conferencia Internacional Mission10 000: Quantum Science & Technologies

Cerrando el ciclo de las Conferencias Mission 10.000, el INL ha albergado la Mission 10.000: Quantum Science and Technologies del 22 al 24 de octubre.
Después del éxito de la edición del 2018, este nuevo programa continuó la iniciativa colaborativa nanoGateway que busca solucionar problemas complejos basándose en aumentar el impacto de la investigación en temáticas de especial relevancia social, involucrando para ello a los principales agentes del área POCTEP.
En los últimos años, varios desarrollos muy importantes han tenido lugar bajo el nombre de la "Segunda Revolución Cuántica". Este movimiento tiene el potencial de hacer posibles varias tecnologías disruptivas, y las Tecnologías Cuánticas tienen el potencial de cambiar profundamente varios sectores económicos, como las comunicaciones seguras por Internet, la logística, las finanzas, la creación de nuevos medicamentos, y la simulación de materiales complejos, entre otros. Estos cambios tendrán ganadores y perdedores. Por lo tanto, es extremadamente importante que las organizaciones académicas, las empresas, los países y las organizaciones transnacionales puedan trazar su Estrategia Cuántica para explotar las oportunidades creadas por la Segunda Revolución Cuántica. Las Tecnologías Cuánticas están directamente vinculadas a la nanotecnología como una forma de hacer posibles tantas otras innovaciones, y las oportunidades que ahora estamos identificando también están vinculadas a las consecuencias adicionales de la digitalización y la globalización.
Durante tres días hemos recibido más de 130 asistentes en un evento destacado por la presencia de tres ponentes principales, dieciséis ponentes invitados y varias contribuciones en presentaciones orales y pósters.
Fuimos testigos del surgimiento de nuevos paradigmas en la física cuántica, cien años después de su descubrimiento, en el conocimiento de materiales cuánticos, tecnologías cuánticas y de la información cuántica. Además, tuvimos el placer de entregar los premios al Mejor Póster y a la Mejor Presentación Oral en esta iniciativa que atrajo a expertos de todo el mundo.

Sinceramente,

Prof. Dr Lars Montelius,
DG, INL

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INTERNATIONAL IBERIAN NANOTECHNOLOGY LABORATORY

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:: FRANK KOPPENS

ICFO

El Profesor Frank Koppens completó su doctorado en Física Experimental en la Universidad de Delft, en el Instituto Kavli de Nanociencia, Holanda.
Koppens es líder de grupo en el Instituto de Ciencias Fotónicas (ICFO). El grupo cuántico nano-optoelectrónico del Prof. Koppens se centra en la ciencia y la tecnología de los nue-vos materiales bidimensionales y cuánticos.
Frank es vicepresidente ejecutivo del principal programa de grafeno, un proyecto de 1,000 millones de europeos en 10 años. El profesor Koppens es Director de GSMA en actividades relacionadas con el Mobile World Congress. Ha recibido cinco premios ERC: la subvención ERC inicial, la beca consolidadora ERC y tres premios de prueba de concepto ERC.
Otros premios incluyen el Christiaan Hugyensprijs 2012, el Premio Nacional de Investiga-ción de España y el Premio Científico de Óptica Joven IUPAP. En total, Koppens ha publicado más de 70 artículos de referencia (índice H sobre 47), con más de 35 en revistas familiares de Ciencia y Naturaleza.

:: CHUN NING (JEANIE) LAU

UC Riverside

Chun Ning (Jeanie) Lau es Profesora en el Departamento de Física de la Universidad Es-tatal de Ohio. Completó su Licenciatura en Física por la Universidad de Chicago en 1994, y un Doctorado en Física por la Universidad de Harvard en 2001.
Fue Investigadora Asociada en Hewlett Packard Labs en Palo Alto entre 2002 y 2004, antes de unirse a la Universidad de California, Riverside, en 2004, como Profesora Asistente. Fue ascendida a Profesora Asociada en 2009 y Profesora Titular en 2012. A partir de enero de 2017, se mudó a la Universidad Estatal de Ohio.
Lau recibió el Premio NSF CAREER y el Premio PECASE en 2008. Su investigación se cen-tra en las propiedades Electrónicas, Térmicas y Mecánicas de los sistemas a nanoescala, en particular el grafeno y otros sistemas bidimensionales.

:: SAMSON ABRAMSKY

University of Oxford

Samson Abramsky es profesor de Computación y Miembro del Wolfson College de la Universidad de Oxford. Tiene un Master por Cambridge y Oxford, y un Doctorado por la Universidad de Londres.
A lo largo de su carrera, ha ganado algunos premios, incluido el Test-of-Time de LICS, la Medalla BCS Lovelace y el Premio Alonzo Church. Más recientemente, Samson ha estado trabajando en métodos de alto nivel para la computación y la información cuánticas.
Samson introdujo la mecánica cuántica categórica con Bob Coecke, el enfoque teórico de la polea de contextualidad y de la no localidad con Adam Brandenburger, y contribuyó ampliamente al desarrollo de una teoría estructural de la contextualidad y sus aplicaciones.
El trabajo actual de Abramsky se centra en la contextualidad como un recurso para la ventaja cuántica. Sus temas incluyen cuantificar la contextualidad y una teoría de los recursos para la contextualidad y las conexiones con los juegos no locales, dando lugar a una mónada cuántica en las estructuras relacionales. Este es un trabajo en curso con varios contribuyentes.

Ponentes Invitados

:: ANTIA LAMAS-LINATES
Speqtral Quantum Technologies

Antia Lamas-Linares es investigadora en información cuántica, especializada en implementaciones ópticas de tecnologías cuánticas. Completó la licenciatura en Física de la Universidad de Santiago, y posteriormente una maestría en Óptica Aplicada del Imperial College de Londres. Obtuvo su doctorado en la Universidad de Oxford en 2003 por su trabajo experimental en óptica cuántica.
Más tarde, Lamas-Linares comenzó su propio grupo de investigación en la Universidad Nacional de Cingapura, donde fue una de las investigadoras principales del Centro de Tecnologías Cuánticas, trabajando en la distribución de claves cuánticas basadas en entrelazado, fundamentos de física, piratería cuántica y propiedades espectro-temporales de fuentes entrelazadas.

:: JUAN JOSÉ GARCÍA RIPOLL
Institute of Fundamental Physics, CSIC

Juan José García Ripoll completó su doctorado en Óptica en la Universidad Complutense de Madrid mientras trabajaba en la Universidad de Castilla La Mancha en condensados Bose-Einstein y óptica no lineal. Más tarde se mudó a Munich con Ignacio Cirac, donde desarrolló importantes con-tribuciones en los campos de la computación de iones cuánticos y ayudó a comenzar el campo de la simulación cuántica con átomos ultrafríos. Juanjo García Ripoll lidera actualmente el Grupo de Información Cuántica del Instituto de Física Fundamental del Consejo Superior de Investigaciones Científicas (CSIC). También es coordinador de la Plataforma Temática de Tecnologías Cuánticas y la Red Española de Información y Tecnologías Cuánticas.

:: LUCAS THIEL
University of Basel

Lucas Thiel es actualmente investigador postdoctoral en la Universidad de Basilea, Suiza, donde completó su doctorado en Física Experimental con el tema: "Senso-rización magnética de baja temperatura utilizando el centro de color del diamante" (2014-2019).

Entre 2013 y 2014, Thiel estuvo en la Universidad de Harvard, Cambridge, EE.UU.
Anteriormente, entre 2011 y principios de 2014, completó su maestría en física en la Universidad de Basilea, instituto donde ya había completado su licenciatura en Nano-ciencia.

Ponentes Invitados

:: UGO DAL LAGO
University of Bologna

Ugo Dal Lago es profesor asociado en la Universidad de Bolonia desde 2015 y miembro de la facultad del Laboratorio de Ciencias de la Computación en la misma institución desde 2006. Antes de eso, fue becario Marie-Curie en la Université Denis-Diderot en París. Ha participado en varios proyectos de investigación internacionales y es coautor de más de 80 publicaciones que aparecen en revistas internacionales y actas de congresos. Ganó el premio a la mejor tesis doctoral italiana en informática teórica (2006), el Kleene Award (2006) y el premio mejor joven investigador en informática teórica (2015). Sus intereses de investigación incluyen la semántica del lenguaje de programación, las probabilidades y la computación cuántica, y la lógica en ciencias de la computación. Dal Lago es el investigador principal del proyecto "DIAPASoN", financiado por la prestigiosa beca ERC para el nivel de Consolidator.

:: JOACHIM VON ZANTHIER
University of Erlangen

Joachim von Zanthier es Profesor Asociado y Líder del Grupo de Trabajo "Óptica Cuántica e Información Cuántica" del Instituto de Óptica, Información y Fotónica de la Universidad Friedrich-Alexander Erlangen-Nürnber, en Alemania. Zanthier completó su doctorado en el Instituto de Óptica de la Universidad de París VI, Francia; y su Licenciatura y Postgrado en Física en Ludwig-Maximilians-Universität, Alemania.
Sus intereses de investigación se centran en la Ingeniería del estado de la luz y la materia, correlaciones espaciales y temporales de fotones no clásicas, interfaces de fotones múltiples en longitudes de onda ópticas y de rayos X, emisión de luz colectiva e imágenes cuánticas.

:: ARTUR GARCIA-SAEZ
Barcelona Supercomputing Center

Artur García-Sáez trabaja en el Centro de Supercomputación de Barcelona. Completó su doctorado en el Instituto de Ciencias Fotónicas (ICFO).
Su investigación se centra en los Métodos de Optimización para Algoritmos Cuánticos, Recocido Cuántico y Técnicas de Aprendizaje para Máquinas de Control Cuántico.
Artur trabajó en la Universidad de Barcelona y en el Instituto Yang de Física Teórica. Investigaciones previas realizadas por él incluyen herramientas de información cuántica para simular sistemas de materia condensada.

Ponentes Invitados

:: ENRIQUE SAHAGÚN

Scixel

Enrique Sahagún estudió Física en Madrid, y completó su doctorado en Física Teórica de la Materia Condensada en la Universidad Autónoma de Madrid. En los últimos años, sus investigaciones contemplan el entendimiento de la dinámica de AFM en entornos disipativos. Antes de esto, Enrique completó su Master en Biofísica.
Profundamente interesado en los gráficos digitales desde el final de los años 90, en 2012 fundó Scixel, un pequeño proyecto dedicado a mejorar la comunicación científica mediante la creación de productos gráficos: fotos, animaciones, documentos, enredos. En los dias de hoy, Scixel desarrolla proyectos visuales para investigadores de todo el mundo.
En particular, Sahagún ha trabajado en TuDelft (Países Bajos), Universidad de Basilea (Suiza), NIMS (Japón) en proyectos relacionados con la Cuántica.

:: FABIO SCIARRINO

University Sapienza

Fabio Sciarrino es Profesor Titular en el Departamento de Física de la Universidad de Roma La Sapienza e Investigador Senior en la Escuela Internacional de Estudios Avanzados de Sapienza, SSAS. Es el Investigador Principal del Quantum Information Lab, Departamento de Física, Universidad Sapienza de Roma.
Sus principales áreas de especialización son la óptica cuántica experimental, la computación y la información cuántica, y los fundamentos de la mecánica cuántica.
En los últimos años, su actividad de investigación se ha centrado en la implementación de protocolos de información cuántica a través de circuitos fotónicos integrados, con especial interés por Boson Sampling, un modelo informático no universal con características prometedoras para lograr la supremacía cuántica.

:: FRANCISCO R. VILLATORO

University of Málaga

La formación académica de Francisco R. Villatoro incluye el Máster en Informática por la Universidad de Málaga (España) en 1992; el Máster en Física por la Universidad Nacional de Educación a Distancia (España), en 1993; y el Doctorado en Matemáticas por la Univer-sidad de Málaga, en 1998.
Desde 1996, Francisco trabaja en el Departamento de Informática e Idiomas de la Univer-sidad de Málaga, donde fue Profesor Asistente, y actualmente es Profesor Asociado.
Sus intereses de investigación se centran en las Ciencias de la Computación y las Matemáticas Aplicadas. Es Research Blogger desde 2008, con una actividad notoria como Comunica-dor de Ciencia en España.

Ponentes Invitados

:: JORGE QUEREDA
University of Salamanca

Jorge Quereda es un Investigador de Doctorado con siete años de experiencia en el campo de materiales y dispositivos bidimensionales.
En junio de 2019, Jorge se unió al grupo de nanotecnología de la Universidad de Salamanca, donde actualmente trabaja como investigador.
Quereda ha publicado 12 artículos científicos en revistas referenciadas, incluidas Nature Communications, Nano Letters o 2D Materials. Sus artículos científicos contienen más de 470 citaciones, con un índice H de 9.
Su trabajo también se ha presentado en seminarios y conferencias científicas nacionales e in-ternacionales, en forma de conferencias invitadas, presentaciones orales y carteles científicos.

:: RAMÓN AGUADO
ICMM-CSIC

Ramón Aguado, doctor en Física Teórica, es Investigador Sénior en el Consejo de Investigación Español (CSIC) y trabaja en el Instituto de Ciencia de Materiales de Madrid (ICMM), donde dirige el grupo "Teoría de materiales cuánticos y tecnologías cuánticas de estado sólido".
Sus principales intereses de investigación se centran en la teoría de la materia condensada, enfocándose en el transporte cuántico, las fuertes correlaciones y los materiales topológicos.
En los últimos años, su actividad se ha concentrado en sistemas superconductores-semiconductores híbridos, donde efectos físicos interesantes como Kondo, transición superconductora BCS o estados magnéticos compiten.
Este interés fundamental, junto con la posibilidad de obtener estados vinculados a Majorana en superconductores topológicos basados en tales sistemas, hace de los híbridos uno de los temas más interesantes en la física moderna de la materia condensada.
Antes de convertirse en científico del CSIC, realizó su investigación de doctorado en el Departamento de Física de la Universidad Estatal de Rutgers de Nueva Jersey y en el grupo de Transporte Cuántico de la Universidad Tecnológica

:: ROSER VALENTÍ
University of Frankfurt

Roser Valenti es profesora de Física en la Universidad Goethe de Frankfurt. Completó su Doctorado en Física Teórica en la Universidad de Barcelona. Antes de matricularse en Frankfurt, obtuvo una beca de investigación Fulbright Posdoctoral en la Universidad de Florida en Gainesville; fue investigadora de Habilitación en la Universidad de Dortmund y recibió una beca de investigación Heisenberg en la Universidad de Saarland, Alemania.
Desde 2016 es becaria de APS, y entre 2009 y 2012 fue vicepresidenta de la Universidad Goethe en Frankfurt. Su campo de investigación se centra en el modelado microscópico de materiales correlacionados, como superconductores no convencionales, imanes y sis-temas de topología no trivial, a través de una combinación de métodos basados en los primeros principios y técnicas numéricas de muchos cuerpos.

Ponentes Invitados

:: LEE ROSEMA

University of Vienna

Lee Rozema trabaja como Templeton Independent Research Fellow en la Universidad de Viena en el grupo de Ciencias de la Información Cuántica y Computación Cuántica con el Profesor Philip Walther.
En 2008 se graduó en Ciencias en la Física y Ciencias en la Informática, siendo uno de los mejores estudiantes de la Universidad de Brock en Canadá.
Completó su Doctorado en 2014 con el profesor Aephraim Steinberg en la Universidad de Toronto. Su investigación de doctorado se ha centrado en una amplia gama de temas, co-mo la óptica cuántica experimental, la información cuántica, desde mediciones de pre-cisión con mejora cuántica hasta temas más fundamentales, como mediciones débiles e interpretaciones de la mecánica cuántica.
Sus temas de investigación actuales incluyen fundamentos cuánticos, computación cuántica fotónica e investigación en nuevas ópticas no lineales.

:: TATIANA G. RAPPOPORT

University of Rio de Janeiro

Tatiana G. Rappoport es Profesora Asociada en el Instituto de Física de la Universidad Federal de Río de Janeiro y actualmente es invitada en la Universidad do Minho.
Como especialista en Materia Condensada, su investigación se centra en las Propiedades Rotacionales, de Carga y Ópticas de Nuevos Materiales Bidimensionales, Espintrónica y Estados Topológicos de la Materia.

:: ASGER MORTENSEN

SDU

Mortensen es profesor titular e investigador VILLUM en el Centro de Nano Óptica y Presidente de Ciencia Técnica en el Instituto Danés de Estudios Avanzados, ambos en la Universidad del Sur de Dinamarca.
Anteriormente, fue profesor titular (facultad desde 2004) en la Universidad Técnica de Dinamarca, instituto donde se graduó [Dr. Techn. (2006), PhD (2001), MSc (1998)]. Es miembro de APS, OSA, SPIE, IOP y EurASc.
Su investigación actual sobre electrodinámica cuántica y no local está financiada por una subvención privada de la Fundación VILLUM [5+ MEUR].

BRAGA, una ciudad encantadora

Braga es una ciudad animada, una de las más antiguas de Portugal, y está llena de jóvenes que estudian en su Universidad.

Construida hace más de 2.000 años, "Bracara Augusta" fue fundada por el emperador romano Augusto. Estaba ubicada en una de las principales vías romanas de la Península Ibérica, era la sede administrativa del Imperio, y más tarde se le otorgó el estatuto de capital de la provincia romana de Gallaecia, actual Galicia, por el emperador Caracalla. La diócesis de Braga es la más antigua de Portugal y, en la Edad Media, la ciudad incluso compitió con Santiago de Compostela en poder e importancia. Uno de los "Caminos de Santiago" pasó por aquí cuando este culto de peregrinación creció después de la reconquista cristiana y la fundación de Portugal.

La **catedral de Braga** también es la más antigua del país y fue construida en el siglo XII por los padres del primer rey de Portugal, D. Henrique y D. Teresa, que están enterrados allí. Braga es hoy en día uno de los principales centros religiosos del país, teniendo las celebraciones de la Semana Santa y el festival de São João como lo más destacado en su calendario litúrgico y turístico.
Además del Tesouro-Museu da Sé (Museo del Tesoro de la Catedral), vale la pena visitar el Museo Biscainhos, ubicado en un palacio barroco, un período histórico en la historia de Braga, y el Museo Arqueológico D. Diogo de Sousa, ya que la ciudad también abunda en restos de la época romana. Sugerimos un paseo tranquilo por el centro histórico para visitar algunas de sus numerosas iglesias, admirar las casas y edificios históricos, como el Palácio do Raio, el Theatro Circo o el Arco da Porta Nova, y tomar un café en la emblemática Brasileira con un vista de la concurrida Avenida Central. Pero Braga también es considerada la ciudad más joven de Portugal y, desde sus puntos de referencia contemporáneos, se destaca el Estadio Municipal de Braga, diseñado por Souto Moura, uno de los arquitectos portugueses más prestigiosos y ganador del Premio Pritzker.

Theatro Circo fue promovido en 1906 por un grupo de personas de Braga, dirigido por Artur José Soares, José António Veloso y Cândido Martins. Hasta esa fecha, la ciudad solo tenía el pequeño Teatro São Geraldo. En 1911, el proyecto comenzó a tomar forma por la mano del arquitecto João de Moura Coutinho y el 21 de abril de 1915 se inauguró Theatro Circo, coincidiendo con un período de gran desarrollo económico y social en Braga. A lo largo de las décadas, el espacio sufrió profundos trabajos de rehabilitación, destinados a la conversión de Theatro Circo en un gran complejo cultural, equipado con la tecnología escénica y sonora más actualizada y completa, capaz de satisfacer las necesidades del arte contemporáneo en sus muchas dimensiones.

Praça da República
Más info: https://visitbraga.travel/braga

Catedral da Sé de Braga
Más info: braga.360portugal.com

Theatro Circo
Más info: www.theatrocirco.com/en

Todos los visitantes de Braga deben ir al **Santuario de Bom Jesus,** un icono de la ciudad, con su monumental escalera, declarado Patrimonio de la Humanidad por la UNESCO en 2019. En medio de una extensión de vegetación, ofrece una excelente vista panorámica de la ciudad, al igual que otras dos iglesias cercanas: el Santuario Nossa Senhora do Sameiro, un importante lugar de culto mariano, y la Iglesia de Santa Maria da Falperra. Bom Jesus es considerado uno de los santuarios más bellos de Portugal y es una referencia del arte barroco en el Pais, con una historia que se remonta al siglo XIV.

Para llegar allí, se puede subir la famosa escalera a la iglesia neoclásica, con 581 escalones, rodeada de magníficos jardines y hoteles. Alternativamente, se puede usar el ascensor que lleva a la parte superior de la escalera. Este ascensor, que funciona desde 1882, es único en la Península Ibérica y el más antiguo del mundo que sigue activo. El elevador se mueve por contrapeso de agua, con dos cabinas, que están conectadas por un cable. La forma original en que funciona este elevador lo convierte en una de las piezas de ingeniería más extraordinarias de Portugal.

Además, también es posible llevar el automóvil arriba y hacer un picnic en los magníficos jardines de Bom Jesus y así disfrutar del aire fresco de la naturaleza y de los impresionantes paisajes. La puesta de sol vista desde aquí le da un sentido completamente nuevo al concepto de "hora dorada".

En los últimos años, la Universidad de Minho y la calidad de la arquitectura contemporánea han inculcado una atmósfera de vitalidad juvenil que ha llevado a esta antigua ciudad a un nivel inesperado de modernidad.

Todos estos atributos fueron primordiales para que Braga fuera considerado el **Segundo Mejor Destino de Europa en 2019** en el concurso promovido por "**European Best Destinations**".

Bom Jesus de Braga
Más info: www.youtube.com (Aerial view in 4k)
https://bragacool.com/visitar/bom-jesus-monte
https://www.travelingwithaga.com/how-to-visit-bom-jesus

Jardim de Santa Bárbara
Más info: braga.360portugal.com

Aquí puedes descargar una tour guide con más información sobre Braga:
https://visitbraga.travel/pub/media/guia/roteiro_braga.pdf

Contributed Talks
Apresentações Orais
Presentaciones Orales
- ABSTRACTS -

Contributed Talks
Apresentações Orais
Presentaciones Orales

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:: **Topological insulator quantum dots grown by molecular beam epitaxy |** Marcel Claro, INL

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Competition between canted antiferromagnetic and spin-polarized quantum Hall states at ν = 0 in single layer graphene on a ferrimagnetic insulator

Yang Li[1], Mario Amado [1,2], Timo Hyart[3],Grzegorz. Mazur[3], Vetle Risinggård[4,5], Thomas Wagner[1,6], Lauren McKenzie-Sell[1,7], Graham Kimbell[1,7], Joerg Wunderlich[6], Jason W. A. Robinson[1]

(1) Department of Materials Science and Metallurgy, University of Cambridge, CB3 0FS, United Kingdom.

(2) Nanotechnology group, Faculty of Physics, University of Salamanca E37008 Spain.

(3) International Research Centre MagTop, Institute of Physics, Polish Academy of Sciences, PL-02668 Warsaw, Poland.

(4) Department of Physics, Norwegian University of Science and Technology, N-7491 Trondheim, Norway.

(5) Center for Quantum Spintronics, Department of Physics, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway.

(6) Hitachi Cambridge Laboratory, Cambridge CB3 0HE, United Kingdom.

(7) Cavendish Laboratory, University of Cambridge, Cambridge CB3 0HE, United Kingdom.

We report a proximity-induced magnetic exchange field in exfoliated single layer graphene (SLG) of the order 60 T by placing SLG on the insulating ferrimagnetic $Y_3Fe_5O_{12}$ (YIG). From nonlocal electrical resistance measurements of SLG/YIG Hall bars in the ν = 0 quantum Hall state, we are able to tune the magnetic order and the energy gap of the edge modes in SLG with relatively small out-of-plane magnetic fields of 8-12 T at 2.7 K, thus demonstrating a low field competition between the canted antiferromagnetic and spin-polarized quantum Hall states at ν = 0. The key to this breakthrough relates to being able to deposit atomically flat bulk-like thin-film YIG which is critical for achieving a uniform coupling of SLG on YIG.

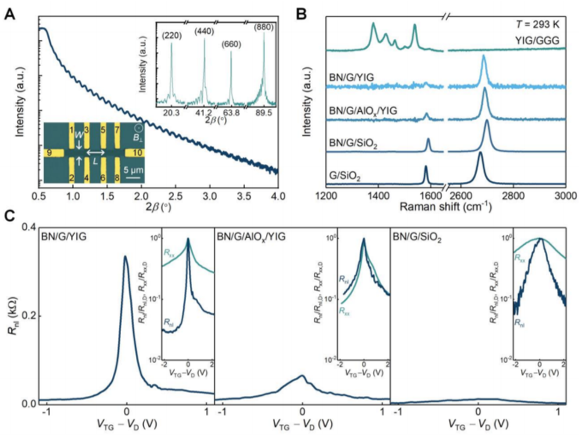

Figure *Device and transport properties in zero external magnetic field. (A) Low angle X-ray reflectometry of (110) YIG confirming a thickness of 84 nm and vertical roughness of ~0.14 nm. (Upper inset) High angle X-ray diffraction of single phase (110) YIG. (Lower inset) Optical micrograph (false color) of a representative hBN/SLG/YIG Hall bar where B⊥ indicates an out-of-plane magnetic field. (B) Raman spectra at 293 K for different structures (labelled) in which the background Raman spectra from BN and YIG/GGG are subtracted. (C)* R_{nl} *vs* $(V_{TG} – V_D)$ *at 9 K for hBN/SLG/YIG and control Hall bars (labelled) with insets showing* $R_{xx}/R_{xx,D}$ *and* R_{nl}/R_{nl}*,D vs* $(V_{TG} – V_D)$ *for the same Hall bar.*

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Topological insulator quantum dots grown by molecular beam epitaxy

Marcel S. Claro[1,3], Ido Levy[1], Abhinandan Gangopadhyay[2], David J. Smith[2], Maria C. Tamargo[1]
(1) The City College of New York, New York, NY 10031, USA
(2) Arizona State University, Tempe, AZ 85287, USA
(3) INL – International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal

Three-dimensional TIs, such as Bi_2Se_3 and related materials, are insulators in the bulk form, usually with a narrow band gap. However, they have surface states with spins that are locked with momentum and protected by time-reversal symmetry [1]. The control of these states can be useful for distinct applications, including quantum computing, dissipation-less electronics and spintronics [1]. Some properties of these materials, especially those related to spintronic and quantum computing, can be enhanced by the electronic confinement in all three dimensions, in quantum dots (QDs) [2]. However, very few experiments have been done in this direction due to the lack of means to fabricate mesoscopic TIs in a reproducible and controlled way. We report the growth of self-assembled Bi_2Se_3 quantum dots (QDs) by molecular beam epitaxy using the droplet epitaxy technique [3], a commonly used technique for III-V semiconductors QDs, however, to our knowledge, never applied to TIs. Characterization by atomic force microscopy, scanning electron microscopy, X-ray diffraction, high-resolution transmission electron microscopy and X-ray reflectance spectroscopy shows that the quantum dots are crystalline, with hexagonal shape, and have average dimensions of 12-nm height (12 quintuple layers) and 46-nm width, and a density of $8.5x10^9$ cm^{-2}. Uncapped and ZnSe-capped Bi_2Se_3 QDs were demonstrated. ZnSe is a wide-bandgap material which could work as embedding matrix and barrier.

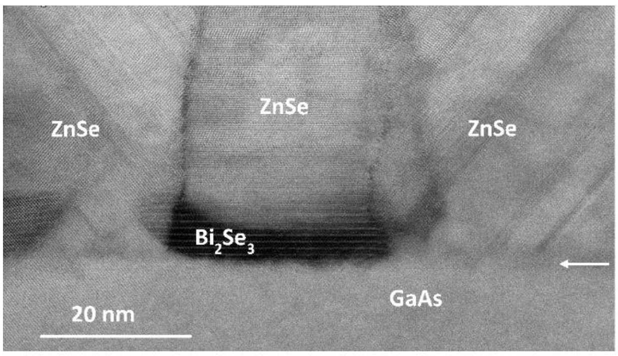

Figure 1 *High-resolution scanning transmission electron micrograph recorded using large-angle bright-field imaging mode, showing Bi_2Se_3 QDs capped with 100 nm of ZnSe.*

NSF grant number HRD-1547830, DMR-1420634

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Itinerant fermion description of topological spin waves in monolayer CrI_3

António T. Costa [1], Daniel L. R. Santos[3], Nuno Peres [1,2], J. Fernandez-Rossier[1]
(1) Internation Iberian Nanotechnology Laboratory, Braga, Portugal
(2) Center of Physics, University of Minho, Braga, Portugal
(3) Centro Federal de Educação Tecnológica, Itaguaí 23812-101, Rio de Janeiro, Brazil

We present a theory of spin waves in ferromagnetic CrI_3 monolayers based on the calculation of the renormalized spin susceptibility, computed using an extended multi-orbital Hubbard model obtained from first-principles calculations. Our theory includes the multi-orbital nature of Cr and I atoms, as well as their spin orbit coupling and yield the spin waves as poles from the spin susceptibility tensor. For monolayers, the theory reproduces the spin wave dispersion measured with inelastic neutron scattering, with a gap at the Dirac point compatible with a topological origin. We have computed the spin waves for a ribbon and find in-gap chiral edge states that provide further back-up to this scenario. Importantly, our approach does not require to define spin Hamiltonian, and can be applied to a wide class of magnetic 2D materials.

Searching through Hamiltonian spectra with quantum phase estimation

Pedro Q. Cruz [1,2], Gonçalo Catarina[1], Joaquín Fernández-Rossier[1]
(1) QuantaLab, International Iberian Nanotechnology Laboratory (INL)
(2) Departamento de Física e Astronomia, Faculdade de Ciências da Universidade do Porto

Quantum phase estimation (QPE) [1,2] is a central algorithmic procedure in quantum computation. It provides a solution to several important problems, such as that of estimating the energy levels of high-dimensional Hamiltonians by simulating quantum dynamics. However, the implementation of the program faces a number of difficulties in NISQ devices on account of the high circuit depth needed. An improvement is made possible by the semiclassical quantum Fourier transform [3], with which it is possible to execute it with only one readout qubit. Recently, we proposed [4] a new estimator to be used with the output probability distribution of this algorithm, introducing a new direction to post-process QPE results. In this presentation, I will describe our optimized use of QPE to explore Hamiltonian spectra in both emulated fault-tolerant quantum computers and real devices.

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Anomalous Kerr effect in two-dimensional massive Dirac materials

G. Catarina [(1)], N. M. R. Peres [(1,2)], J. Fernández-Rossier [(1)]
[(1)] QuantaLab, International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal
[(2)] Centro de Física das Universidades do Minho e Porto and Departamento de Física and QuantaLab, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

Two-dimensional massive Dirac electrons possess a finite Berry curvature, with Chern number ±1/2, that entails both a quantized Hall response [1] and a subgap full-quarter Kerr rotation [2]. The observation of these effects in two-dimensional gapped Dirac materials, such as transition metal dichalcogenides [3], is obscured by the fact that Dirac cones come in pairs with opposite sign Berry curvatures, leading to a vanishing Chern number. Here, we show that the presence of strong spin-orbit interactions combined with an exchange-driven band-dependent spin splitting, induced either by a small density of magnetic impurities [4] or by proximity to a ferromagnetic insulator [5], permits to unveil the anomalous Kerr effect in magnetized transition metal dichalcogenide monolayers.

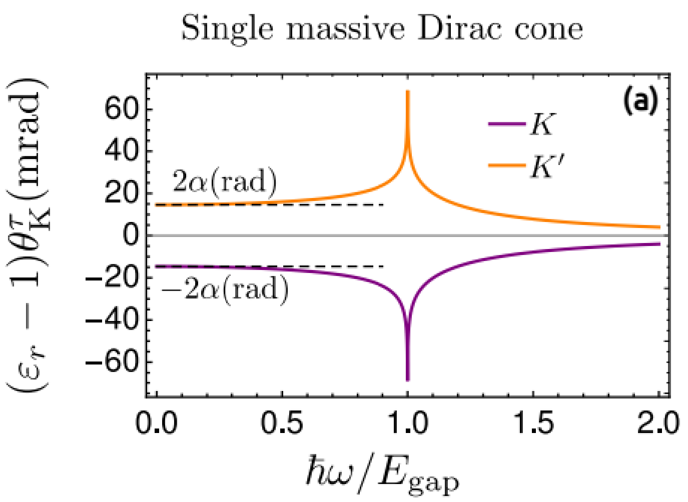

Figure *Valley-resolved Kerr rotation θ_K^τ, as a function of the photon energy $\hbar\omega$, for a two-dimensional material described by a massive Dirac theory with gap E_{gap}, at the charge neutrality point, on top of a substrate with relative permittivity $\varepsilon_r \gtrsim 2$. The sum over the two valleys, K and K', leads to a vanishing net Kerr effect. A combination of both spin-orbit coupling and different exchange-driven spin splitting in the valence and conduction bands gives rise to four non-degenerate effective gaps, which offsets this cancellation.*

G. C. acknowledges Fundação para a Ciência e a Tecnologia (FCT) for the Grant No. SFRH/BD/138806/2018. G. C. and J. F.-R. acknowledge financial support from FCT for the Grant No. P2020-PTDC/FIS-NAN/4662/2014. N. M. R. P. acknowledges financial support from the European Commission through the project "Graphene-Driven Revolutions in ICT and Beyond" (Ref. No. 785219) and FCT in the framework of the Strategic Financing Grant No. UID/FIS/04650/2013. Additionally, N. M. R. P. acknowledges COMPETE2020, PORTUGAL2020, FEDER and FCT for the Grants No. PTDC/FIS-

Topologically protected quantization of work

Bruno Mera* and Yasser Omar
Instituto de Telecomunicações, Lisboa and
Instituto Superior Técnico, Universidade de Lisboa, Portugal

Krzysztof Sacha
Instytut Fizyki imienia Mariana Smoluchowskiego, Uniwersytet Jagielloński,
ulica Profesora Stanisława Łojasiewicza 11, PL-30-348 Kraków, Poland
(Dated: July 30, 2019)

The transport of a particle in the presence of a potential that changes periodically in space and in time can be characterized by the amount of work needed to shift a particle by a single spatial period of the potential. In general, this amount of work, when averaged over a single temporal period of the potential, can take any value in a continuous fashion. Here we present a topological effect inducing the quantization of the average work. We find that this work is equal to the first Chern number calculated in a unit cell of a space-time lattice. Hence, this quantization of the average work is topologically protected. We illustrate this phenomenon with the example of an atom whose center of mass motion is coupled to its internal degrees of freedom by electromagnetic waves.

We are grateful to Tomasz Kawalec for a fruitful discussion concerning experimental aspects. B.M. and Y.O. thank the support from Fundação para a Ciência e a Tecnologia (Portugal), namely through programme POCH and projects UID/EEA/50008/2013, UID/EEA/50008/2019 and IT/QuNet, as well as from the JTF project NQuN (ID 60478) and from the EU H2020 Quantum Flagship projects QIA (820445) and QMiCS (820505). B.M. also acknowledges the support of H2020 project SPARTA, projects QuantMining POCI-01-0145-FEDER-031826, PREDICT PTDC/CCI-CIF/29877/2017 and QBigData PEst-OE/EEI/LA0008/2013, by FCT. The authors acknowledge the support from the project TheBlinQC supported by the EU H2020 QuantERA ERA-NET Cofund in Quantum Technologies and by FCT (QuantERA/0001/2017) and National Science Centre Poland No. 2017/25/Z/ST2/03027.

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* bruno.mera@tecnico.ulisboa.pt

Excitonic effects on the magneto-optical properties of ferromagnetic 2D materials

Alejandro Molina-Sánchez(1) and Joaquín Fernández-Rossier(1)

(1) International Iberian Nanotechnology Laboratory (INL), Av. Mestre José Veiga, 4715-330 Braga, Portugal

The recent discovery of ferromagnetic 2D materials is increasing the potential applications of 2D materials. Monolayer crystals of chromium trihalides like CrI_3 are semiconducting materials and exhibit magnetic order. In addition, they have also a strong coupling with light due to the excitonic effects, especially strong in 2D materials. These magneto-optical properties open the way for their use in spintronics devices [1,2].

Measurements of the magneto-optical Kerr effect are essential to demonstrate the magnetic behavior of monolayer chromium trihalides but the microscopic origin and understanding of magneto-optical signal is still unknown. In this work, we have combined density-functional theory with many-body perturbation theory to calculate the electronic structure, the excitonic states of monolayer chromium trihalides, CrI_3, $CrBr_3$ and $CrCl_3$. Moreover, we have calculated the optical absorption and Kerr angle spectra. We demonstrate the strong enhancement of the Kerr angle due to the impact of the excitonic effects on the optical properties, characteristic of 2D materials. We have also investigated the role of the ligand on the magneto-optical properties like the circular dichroism and the influence of the magnetization orientation on the optical properties. We find that the ac Hall response increases with the atomic weight of the halide atom. This indicates that that the spin-orbit coupling of the ligand controls the anomalous Hall response, as it also does with the magnetic anisotropy.

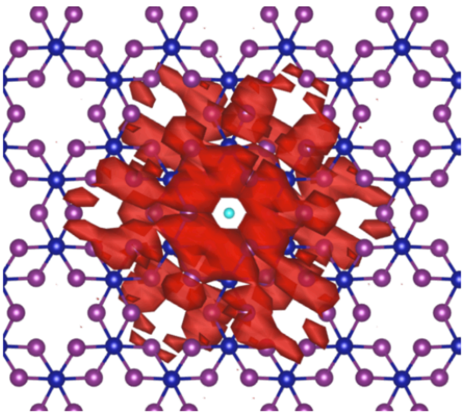

***Figure**. Excitonic density of the exciton ground state of monolayer CrI_3.*

The authors acknowledge funding from NanoTRAINforGrowth II Programme (MSCA-COFUND) and project UTAPEXPL/NTec/0046/2017.

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Quantum Berry Phase Estimation

Gonçalo Catarina (1), Bruno Murta (1), J. Fernández-Rossier (1,2)
(1) International Iberian Nanotechnology Laboratory
(2) Department of Applied Physics, University of Alicante

Given the limitations of current quantum hardware, hybrid variational procedures have taken the spotlight in digital quantum simulation, having led to some successes such as the determination of ground state energies of simple molecules [1]. The feasibility of the application of these algorithms to larger systems, particularly those of interest in condensed matter physics, is compromised by the orthogonality catastrophe [2], though. Adiabatic evolution arises as an alternative approach that does not face this issue and is thus more suited to simulate quantum many-body phenomena [3]. The development and consolidation of algorithms and procedures to adiabatically evolve quantum systems in noisy intermediate-scale quantum computers is therefore an important step towards the ultimate goal of using quantum computers to solve quantum many-body problems that are otherwise unsolvable. In this talk, I shall present a quantum algorithm to measure the Berry phase of simple adiabatically-evolved systems. In particular, I shall show that, despite the high circuit depth imposed by the adiabatic condition, the results obtained with superconducting qubits are consistent with the analytical expressions after the application of error-mitigating post-processing methods [4,5].

B.M. and J.F.R. acknowledge financial support from FCT Functionalized Graphene for Quantum Technologies project (PTDC/FIS-NAN/4662/2014). G.C. acknowledges the FCT PhD scholarship no. SFRH/BD/138806/2018.

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Temporal dynamics of hexagonal boron nitride single quantum emitters

Bruno Romeira(1,2)*, Balaji Sompalle(1,3)*, Lisa-Marie Otto(1,2)*, Pedro Alpuim(1,3,4) , Jana B. Nieder(1,2)

(1) QuantaLab, INL – International Iberian Nanotechnology Laboratory, 4715-330, Braga, Portugal
(2) Department of Nanophotonics, Ultrafas, Bio- and Nanophotonics
(3) Department of Quantum and Energy Materials, 2D Materials and Devices
(4) Center of Physics, University of Minho, 4710-057, Braga, Portugal
*Equally contributing authors

Sources of single photons at room-temperature are urgently needed for many emerging quantum information technologies such as quantum computation, communication, and sensing. Graphene and hexagonal boron nitride (hBN) materials have emerged as promising platforms for nanophotonic and solid-state quantum information processing devices [1-3]. Recently, photostable single photon quantum emitters showing ultrabright and stable emission under ambient conditions were reported from atomic defects in layered hBN [4-5]. Here we report the spatial, spectral, and temporal dynamic emission properties in chemical vapor deposition (CVD)-grown hexagonal boron-nitride materials and compare the emission profiles when the surface of the hBN material is covered by graphene directly deposited on hBN by CVD. In the case of hBN material only, the emitters investigated show a rich blinking characteristic dynamics, also observed in several other studies, which can be interpreted as being due to the distribution of charge-traps at the surface of the material. In the situation of graphene directly in contact with hBN we observe an increase of photostability and complete elimination of blinking phenomena. This behavior provides strategies for blinking reduction and increase of photostability through reduction of charge traps at the surface of hBN materials. The results presented here can have a strong impact on the design of 2D graphene/hBN heterostructure-based single emitter devices for quantum information technologies.

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Quantum advantage from energy measurements

Leonardo Novo (1), Juani Bermejo-Vega (2), Raul Garcia-Patron (1)
(1) Centre for Quantum Information and Communication, Ecole Polytechnique de Bruxelles, Université Libre de Bruxelles, Belgium
(2) Freie Universität Berlin, Berlin, Germany

A central challenge in the field of quantum computation is to demonstrate that a quantum device can show an unambiguous computational advantage over classical computers. Although several quantum algorithms exhibit an advantage when compared to the best-known classical algorithms for the same problem, it is hard to guarantee that future algorithmic developments will not erase these advantages.

Recently, a considerable research effort has been devoted towards demonstrating a more reliable quantum advantage from simple quantum circuits that could conceivably be implemented in the near-term. These proposals are based on sampling problems on a variety of architectures, such as boson sampling [1], IQP sampling [2] or sampling from random quantum circuits [3]. For these quantum devices, the existence of an efficient classical simulation is discarded assuming long-standing and widely believed complexity theoretical conjectures, such as the non-collapse of the Polynomial Hierarchy. Unfortunately, these sampling problems are rather artificial, in that they were constructed with the primary purpose of being hard to simulate classically.

In this work, we focus on demonstrating quantum advantage for more physically motivated problems, by considering the problem of simulating energy measurements on simple-to-prepare, product quantum states. We give examples of local Hamiltonians and regimes of resolution and error parameters characterizing the measurement that can be efficiently reached by quantum devices, while providing strong complexity theoretic evidence for the impossibility of efficient classical methods to simulate such measurements. We believe this is an important step towards bringing quantum advantage demonstrations to more physically motivated problems, occurring naturally in many-body physics.

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Excitonic core-shell nanoparticles with plasmon-like response

S. Núñez-Sánchez(1), C. Estevez-Varela(1), O. Savchuk(2), J. Perez-Juste(1),
J. B. Nieder(2), I. Pastoriza-Santos(1),
(1) Departamento de Química Física & CINBIO, Universidade de Vigo, Spain.
(2) Nanophotonics Department, Ultrafast Bio- and Nanophotonics group, INL - International Iberian Nanotechnology Laboratory, Braga, Portugal.

Plasmonics and metamaterials have been a driving force for nanotechnology applications allowing to concentrate light right down to the nanoscale. Metals such as gold or silver have been the material platforms for the plasmonic revolution. In this work we show that organic materials can be the key to confine light at nanoscale and to enhance light matter interactions. [1, 2] Moreover, we will show that it is possible to define colloid chemistry routes to design organic building blocks which can establish the fundamentals towards fully plastic quantum metamaterials.

In this work, we have synthesized and studied stable colloidal dispersions of excitonic core-shell nanoparticles. These core-shell nanoparticles are formed by a core of silica and a shell of densely packed J-aggregates (see figure 1.a). The role of the silica nanoparticles is to provide the inorganic scaffold for the molecular J-aggregates, which will provide the plasmon-like properties to the colloids. The optical response of the hybrid nanoparticles was studied as a function of the number of J-aggregate layers deposited at the surface of the silica nanoparticles. For low layer numbers, an absorption peak is observed on top of the silica core optical response due to the inherent absorption of J-aggregates. As the loading of J-aggregates increases, a new excitonic resonance appears, which can only be explained by a plasmon-like resonance, a localized surface exciton resonance-LSER. We confirm the experimental results by numerical simulations, revealing the potential use of J-aggregate materials as excitonic alternatives to metal-based plasmonic structures for enhanced light matter interaction at nanoscale (see Figure 1.b). Finally, we will discuss the relation between the steady state and dynamic fluorescence response of the dye-forming the shell. To our knowledge, this is the first experimental evidence that excitonic plastics can show plasmon-like response in nanostructures opening the way to a new fully plastic era in quantum plasmonic metamaterials.

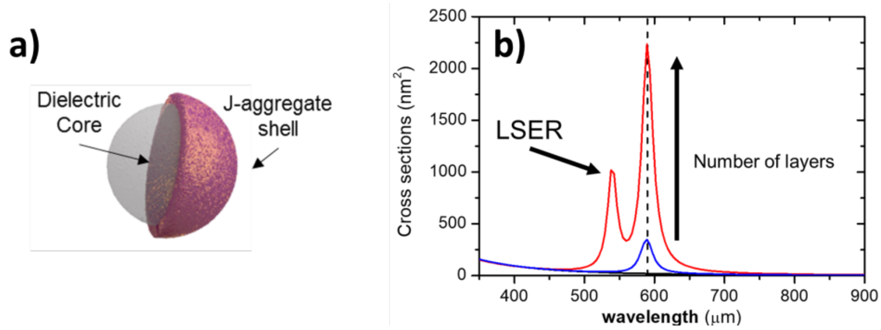

Figure 1.- *a) Graphical representation of the excitonic core-shell nanoparticles. b) Mie simulations of extinction cross sections of the excitonic core-shell nanoparticles as a function of J-aggregate layers.*

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Quantum Oblivious Keys for Secure Multiparty Computation

Armando N. Pinto [1, 2], Mariana F. Ramos [1, 2], Nelson J. Muga [1, 2], Nuno A. Silva [1, 2]
(1) Departamento de Eletrónica, Telecomunicações e Informática, Universidade de Aveiro, Portugal
(2) Instituto de Telecomunicações, Aveiro, Portugal

We present recent experimental results [1, 2] obtained in our laboratory related with the exchange of qubits using polarization encoding to generate oblivious keys to support secure multiparty computation. We show how the exchange of qubits can be performed in optical fibers using single-photons. We discuss the polarization encoding method and single-photon detection, as well as polarization information retrieval. We present a method to compensate the polarization random drifts, allowing continuous communication over the quantum channel, with a very low overhead. We also present a protocol to build the key, and we discuss its usage in secure multiparty computation. The exchange of qubits allows two untrusted entities, usually called Alice and Bob, to build an oblivious key. This oblivious key can be used to perform generic secure multiparty computation, using garble circuits, allowing the computation of any function preserving the privacy of Alice and Bob inputs. The usage of quantum technologies [3] allows the secure exchange of oblivious keys at a much higher rate than what is possible using classical cryptography. This approach has also the advantage of being secure even in the presence of a quantum computer, which could enablethe future widespread usage of secure multiparty computation.

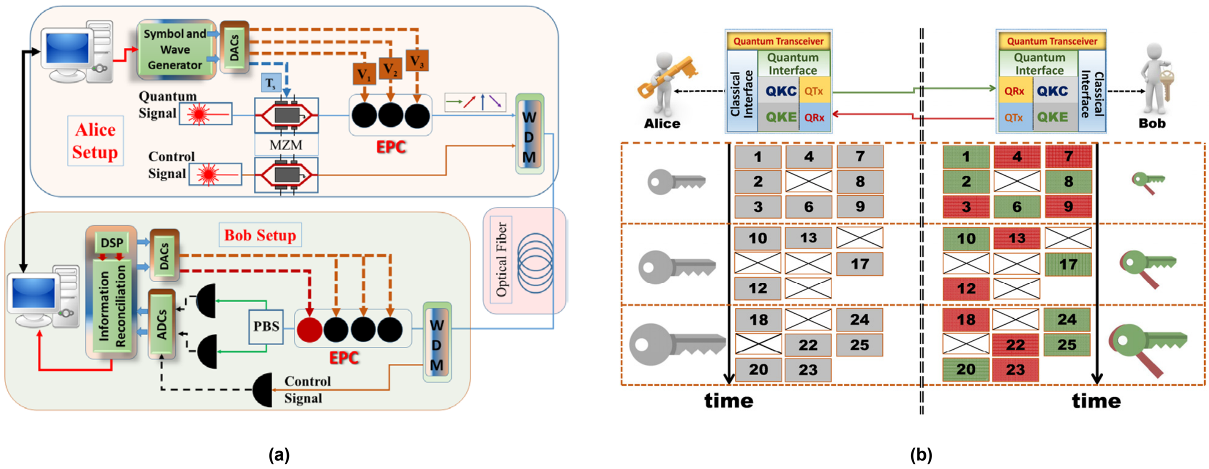

***Figure** 1 – (a) Experimental setup used to exchange qubits with polarization encoding. (b) Oblivious keys build between Alice and Bob used to perform secure multiparty computation*

Acknowledgments:
This work is supported by FCT through national funds, by the European Regional Development Fund (FEDER), through the Competitiveness and Internationalization Operational Program (COMPETE 2020), and by Regional Operational Program of Lisbon, under the projects QuantumMining (POCI-01-0145-FEDER-031826), and UID/EEA/50008/2019.

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Quantum Kolmogorov complexity of quantum states and correlations

M. Lemus [1][2], P. Mateus [1][2], R. Faleiro [1][2], N. Paunkovic [1][2] and A. Souto [1][3]

(1) Instituto de Telecomunicações, Avenida Rovisco Pais 1049-001, Lisboa, Portugal
(2) Departamento de Matemática, Instituto Superior Técnico, Universidade de Lisboa, Avenida Rovisco Pais 1049-001, Lisboa, Portugal
(3) Departamento de Matemática, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

In this work we generalize the definition of the deterministic control quantum Turing Machine (dcq-TM) introduced in [1] to the case of mixed quantum states. This allows for potential use of the model in interactive protocols. Additionally, building upon the definition of Quantum Kolmogorov complexity *(QKC)* of pure states from [1], where the smn property of the dcq-TM was exploited, we introduce a natural extension *of QKC* to mixed quantum states using the notion of state purifications. We also present a definition of the *QKC* for quantum correlations and introduce two inequivelent alternatives for mutual information. Finally, we prove a quantum version of the known Brudno's *theorem*.

This work was funded by PEst-OE/EEI/LA0008/2013 of Instituo de Telecomunicações and ref. UID/CEC/00408/2013 of LASIGE throughout FCT.

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Reliable characterization of IBM Q devices

Henrique Silvério [1,2], Pedro Ribeiro [2], Joaquín Fernández-Rossier [1]

(1) QuantaLab, International Iberian Nanotechnology Laboratory (INL), Av. Mestre José Veiga, 4715-330 Braga, Portugal
(2) CeFEMA, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

The advent of the public-access quantum computer, pioneered by IBM, has led to widespread implementation of simple quantum algorithms on real, noisy quantum devices. Being in its early stages of development, the IBM Q quantum processors display recurrent mismatches between simulated and experimental results, thus begging for a more detailed diagnosis of the existent errors. In this work, we present a reliable characterization of IBM Q's single-qubit processes using Gate Set Tomography [1,2], a technique that supersedes old-school Quantum Process Tomography in reliability and generates a far more detailed description of a system than its favoured Randomized Benchmarking counterpart. Our preliminary results consist of a complete characterization of the single-qubit processes implemented at the hardware level, including state preparation and readout, based solely on experimental data acquired remotely. Besides agreeing with the gate and readout errors reported by the IBM team, these results facilitate the simulation of the real outcome of arbitrary single-qubit circuits. In terms of IBM Q's performance, they show that readout errors are frequently most detrimental to a computation, far outweighing the influence of single-qubit gate errors.

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A dynamic logic for QASM programs

Carlos Tavares (1) (2)

(1) High-assurance software laboratory/INESCTEC, Braga, Portugal
(2) Department of Informatics, University of Minho, Campus Gualtar, Braga

The topic of quantum programming has been subject of extensive research in the past 20 years, producing a relevant set of theoretical tools, such as programming languages, calculus and logics, which have become especially relevant with the appearance of the first quantum computers and commercial quantum programming languages. The Quantum Assembly Language [1] is a quantum circuit specification language, serving as an intermediate representation of quantum circuits between high-level quantum programming languages and quantum hardware, in use in the commercially available quantum hardware platforms supplied by IBM [4]. The language itself, besides the definition of quantum circuits, allows the use of intermediate measurements and the storage of the resultant values in classical variables, which can later be used to control the flow of the execution of further quantum instructions, by means of if statements, which make the language to fall under the "quantum data with classical control paradigm", i.e. quantum programs involving quantum and classical information where non-unitary operations, such as measurements, are permitted [PSV14]. We propose a dynamic logic for the quantum assembly programming language (QASM), by combining ideas from the existent works in dynamic logic of Baltag et al. [2,3], for quantum systems, and of Kozen et al. [5] for probabilistic systems. We propose a syntax and a semantics based on a Kripke model, where programs are presented as a product of probabilistic and quantum components and we exercise the logic with simple quantum-classical protocols.

Acknowledgements

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Quantum simulation of diatomic molecules: a case study using IBM-Q

Carlos Tavares [1], Sofia Oliveira [1,2], Vitor Fernandes [1,2], Mikhail I. Vasilevskiy [2,3]
(1) Department of Informatics, University of Minho, Campus de Gualtar, Braga, Portugal
(2) Department of Physics, University of Minho, Campus de Gualtar, Braga, Portugal
(3) International Iberian Nanotechnology Laboratory, Braga, Portugal

As quantum computing approaches its first commercial implementations, quantum simulation emerges as a potentially ground- breaking technology for several domains, including biology and chemistry. Taking advantage of quantum algorithms in Quantum Chemistry raises a number of conceptual and practical challenges at different levels, from the conception to its actual execution.

We go through such challenges in a case study of a quantum simulation for the hydrogen (H_2) and Lithium-hydride (LiH) molecules, in an actual commercially available quantum computer, the IBM-Q. The simplest possible molecule, H_2, has always been the polygon for testing approximate calculation methods in Quantum Chemistry [1] and LiH is just a little bit more complex since it lacks the mirror symmetry of the former. We use the STO-LG type atomic orbitals to construct the minimal basis of molecular orbital and write down the molecule Hamiltonian in the second quantization representation, where we include an additional term due to an external stationary electric field. It allows as to analyze, beyond the ground state energy versus interatomic distance, also the molecular Stark effect. The Hamiltonian is then transformed into a spin representation using the Jordan-Wigner transformation using the known recipes that can be found e.g. In Ref. [2]. This form of the Hamiltonian allows for constructing a quantum circuit for measuring the ground state energy of the system; it depends on parameters of the basis functions used. The final step consists in using a classical non-linear optimizer to minimize the expectation value by varying some of these parameters. This is implemented in the Variational-Quantum-Eigensolver (VQE), used by us.

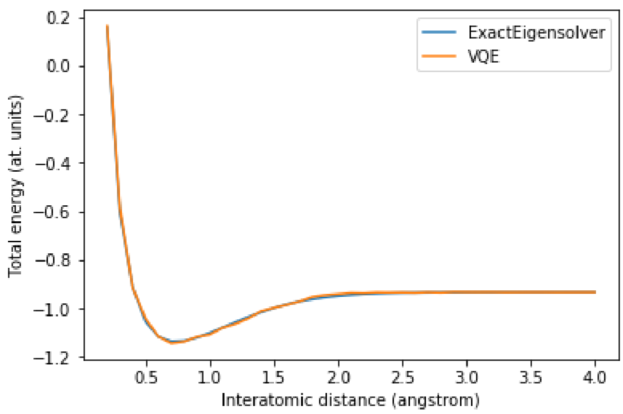

***Figure** 1. Dissociation curve of the H_2 molecule calculated using the VQE and an exact classical eigensolver.*

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Strong coupling between Surface Exciton Polaritons and complementary optical modes in multicomponent thin film structures

William P Wardley[(1)], Sara Núñez Sánchez[(2)] & Martín López García[(1)]

(1) Nanophotonics Dept, International Iberian Nanotechnology Laboratory, 4715-330 Braga, PT.
(2) Colloid Chemistry Group, Departamento de Química Física, Universidade de Vigo, Spain

Surface Exciton Polaritons (SEPs), the coupling between a photon and an exciton analogous to a surface plasmon polariton in metals, can be seen in the collective behaviour of films containing a high density of strong molecular dipoles, such as J-aggregates(1). These show many of the same properties of plasmonics, such as high field enhancement and localisation, environmental sensitivity and travelling wave behaviour but with additional benefits from soft-material platforms, such as flexibility and low cost.

In addition to the interest in the inherent behaviour of excitonic-polaritonic polymer films, the wavelength of the collective behaviour of the excitonic system can be chosen to build multicomponent structures with other resonant materials with complementary wavelength response. These multicomponent structures can demonstrate strong coupling between the excitonic resonance and other optical modes, experimentally demonstrated by strong anti-crossing in the optical response, or Rabi splitting(2,3).

Here we show experimental demonstration of coupling between excitons in a J-aggregate film and a range of complementary optical modes, including surface plasmon polaritons in gold (under strong coupling) and Si_3N_4 waveguided modes in a dielectric layer (to investigate SEP waveguiding). Modelling of these scenarios allows us to visualise the mode structure of each of these scenarios, allowing us to suggest potential applications for devices featuring these structures.

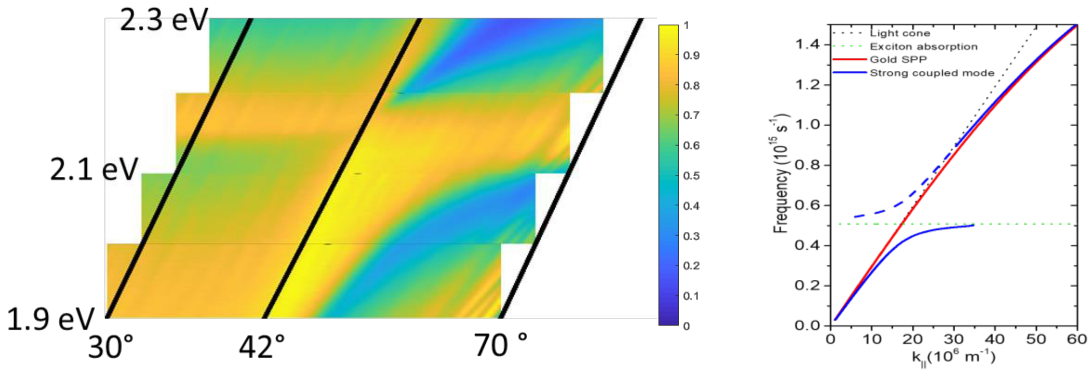

Figure 1a Illustrative plot of preliminary experimental results showing the strong coupling between TDBC and thin film gold in reflectance (arbitrary units). 1b shows the same situation simulated, demonstrating the same strong coupling behaviour.

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- ABSTRACTS -

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02- Yuriko Baba, U. Complutense | **Impact of electric fields on surface states in topological semimetals**

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Single impurity-induced states and simulations in topological insulators

O. Arroyo-Gascón [(1)], R. Martínez [(2)], O. de Abril [(3)], L. Chico [(1)] and F. Domínguez-Adame [(2)]
(1) Instituto de Ciencia de Materiales de Madrid, CSIC, Cantoblanco, ES-28049 Madrid, Spain
(2) Departamento de Física de Materiales, Universidad Complutense, E-28040 Madrid, Spain
(3) Departamento de Estructuras y Física de Edificación, Universidad Politécnica de Madrid, E-28040 Madrid

Topological insulators are known to show gapless metallic surface states at the interface with a normal insulator. The heterostructure formed by these two insulators can be altered by the introduction of impurities near the interface. In this work, a non-magnetic impurity is placed near the junction, giving rise to a Coulomb potential for electrons (**Figure 1**). Electron states are described by a two-band model, which considers the forementioned impurity potential and the characteristic band inversion across the junction.

As a first approach, we use a two-band model Hamiltonian (Dirac-like equation) in two dimensions in order to describe the electron dynamics at the interface. This equation is solved by means of numerical discretization, and a description of the energy spectrum and probability density of the states closest to the zero-energy case is performed in terms of the system parameters. We compare our results with previous works on mid-gap bound states in junctions in the presence of several impurities.

Also, an alternative model introducing a Green's function formalism is put forward to solve the original three-dimensional Hamiltonian, with the electron-impurity interaction now described by a non-local separable potential. We find evidence of resonant states. The same formalism is used to obtain both the density of states at the junction and the impurity-affected density of states. We compare the latter with *ab-initio* DFT simulations of the electronic structure of a topological crystalline insulator, $Pb_{1-x}Sn_xTe$, which has been scarcely described by *ab-initio* simulation techniques so far.

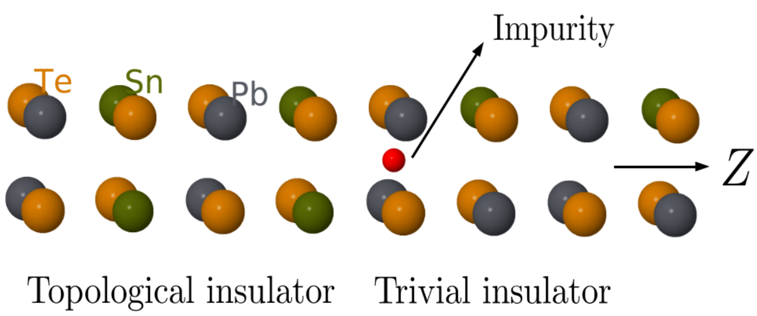

Figure 1. *Atomic structure of a heterostructure consisting of a TI, $PbSnTe_2$, and a trivial insulator, Pb_3SnTe_4, plus a interstitial hydrogen-like impurity.*

Impact of electric fields on surface states in topological semimetals

Yuriko Baba [(1)], A. Díaz-Fernández [(1)], R. A. Molina [(2)], E. Díaz [(1)] and F. Domínguez-Adame [(1)]
(1) Departamento de Física de Materiales, Universidad Complutense de Madrid, Spain
(2) Instituto de Estructura de la Materia, IEM-CSIC, Madrid, Spain

We investigate the consequences of applying electric fields perpendicularly to thin films of topological semimetals. In particular, we consider Weyl and Dirac semimetals [1,2] in a configuration such that their surface Fermi arcs lie on opposite edges of the films [3,4]. We develop an analytical approach based on perturbation theory and a single-surface approximation and we compare our analytical results with numerical calculations. The effect of the electric field on the dispersion is twofold: it shifts the dispersion relation and renormalizes the Fermi velocity (see **Figure 1**), which would, in turn, have direct effects on quantum transport measurements. Additionally, it modifies the spatial decay properties of surface states which will impact the connection of the Fermi arcs in opposite sides of a narrow thin film.

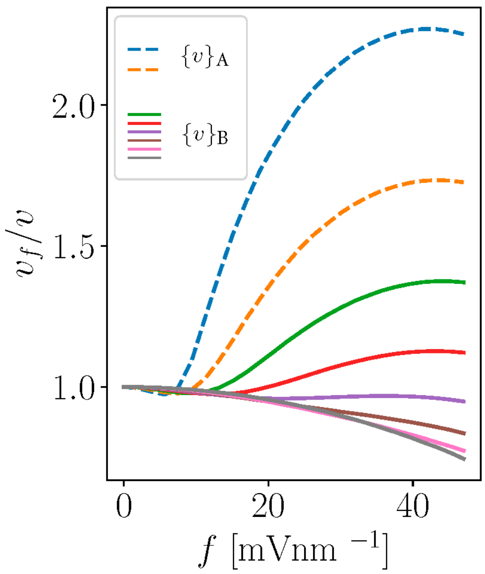

Figure 1. *Evolution of Fermi velocity in units of its bare value as a function of the electric field in a slab of width* $w = 50\,nm$. *The other parameters of the system Hamiltonian* $\mathcal{K}$ *are* $m_0 = 0.35$ eV *and* $m_0 = 0.35$ eV nm^2, *where* $\mathcal{K} = (m_0 - m_1 \boldsymbol{k}^2)\,\sigma_z + v k_z \sigma_x + v\, k_y \sigma_y$. *The values of the velocities plotted are* $\{v\}_A = \{0.8, 1.0\}$ eV nm *and* $\{v\}_B = \{1.2, 1.4, 1.6, 1.8, 2.0, 2.4\}$ eV nm.

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Magnetic Field Mapping using Nitrogen-Vacancy Centers in Diamond

Filipe Camarneiro [(1)], Juanita Bocquel [(3)], Juan Gallo[(2)], Manuel Bañobre-López[(2)], Alexander Huck[(3)], Jana B. Nieder [(1)]
(1) Nanophotonics Department, INL – International Iberian Nanotechnology Laboratory
(2) Life Sciences Department, INL – International Iberian Nanotechnology Laboratory
(3) Center for Macroscopic Quantum States (bigQ), Department of Physics, Technical University of Denmark, Fysikvej 307, 2800 Kgs. Lyngby, Denmark

Nitrogen-Vacancy (NV) color centers in diamond are among the most promising quantum systems for applications in quantum sensing, information processing and communication. The NV system consist of a substitutional nitrogen atom and a neighboring lattice vacancy forming well protected energy states within the bandgap. These energy states are associated with an electron spin and can be readout through the fluorescence intensity. Hence, the NV system can be applied for sensing different physical parameters such as temperature and magnetic fields [1]. Because of the high attainable sensitivity, the diamond biocompatibility [2], and nanometer-scale spatial resolution, NV-centers are of relevance in cell studies [3], diagnosis, therapeutics and material sciences.
In this work, we use a 2 x 2 mm^2 bulk diamond sample with high density areas ~$10^{10} cm^{-2}$ of nitrogen-vacancy centers created via ion implantation and subsequent annealing to measure and map magnetic fields induced by magnetic nanoparticles. We use a confocal microscope with a 532nm laser to excite NV centers while sweeping a microwave field across the sample. The nanoparticles are immersed in a PVA film and investigated with and without an external magnetic bias field. Our results reveal magnetic field magnitudes in the range 10 - 800 μT and a near 1/r decay of the magnetic field over distance as well as a conservation of the magnetization over time.

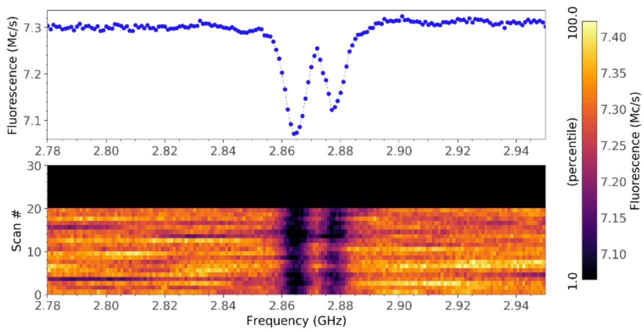

Figure *ODMR measurement showing the presence of a magnetic field.*

The author acknowledges funding from the FCT project QUA-ND-O (POCI-01-0145-FEDER-032619), the COST Action on Nanoscale Quantum Optics (COST MP1403) for supporting the Short Term Scientific Mission and the Novo foundation via the bioQ project.

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Molecular beam epitaxy of 2D chalcogenides: InSe, In_2Se_3, GaSe and their heterostructures

Marcel S. Claro [(1)], Justyna Grzonka [(1)], Paulo Ferreira [(1)], Sascha Sadewasser [(1)]
(1) INL – International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal

The new family of atom-thick materials, known as 2D or layered materials, has shown novel properties compared to their bulk counterparts due to the quantum confinement on their thin layers or enhanced surface states [1]. In particular, the post transition-metal chalcogenides: Indium- and Gallium-Selenide exhibit good transport properties and direct bandgaps ranging from near-infrared to ultra-violet, depending on thickness [2]. These properties place these materials as promising technological options for photonic applications. However, most devices are currently fabricated by cumbersome exfoliation methods. Thus, there is an urgent need for large-area growth methods, so that they become relevant in real-world applications. In this work, we show the growth of a few layers of pure phase InSe, GaSe, In_2Se_3 and their heterostructures, by molecular beam epitaxy, continuously over 2-inch wafers. The produced layers are characterized by Reflection High-Energy Electron Diffraction (RHEED), Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), Raman Spectroscopy, and High Angular Annular Dark Field (HAADF) Scanning Transmission Electron Microscopy (STEM). These analyses provide an understanding of the growth habits, atomic diffusion, segregation, and phase transformations occurring in these materials. We also discuss the crystal quality, presence of defects, the feasibility of heterostructures, as well as their potential for applications.

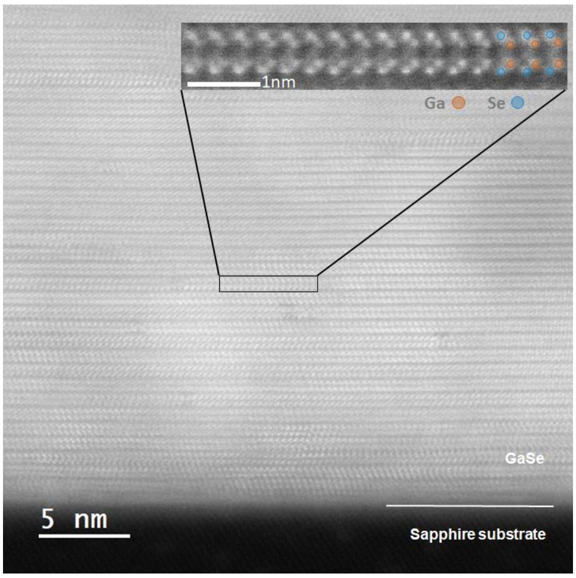

Figure 1. *HAADF STEM image of layered structure of GaSe on 2" Sapphire wafer*

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Quantum Plasmonics and Plasmon–Emitter Interactions at the Nanoscale

P. André D. Gonçalves(1,2,3), T. Christensen(2), N. Rivera(2), A.-P. Jauho(4), M. Soljačić(2), N. Asger Mortensen(1,3)

(1) Center for Nano Optics, University of Southern Denmark, Denmark
(2) Department of Physics, Massachusetts Institute of Technology, Cambridge, MA, USA
(3) Center for Nanostructured Graphene, Technical University of Denmark, Denmark
(4) Department of Physics, Technical University of Denmark, Denmark

We develop a multiscale theory for quantum nanoplasmonics [1,2] that accounts for quantum mechanical effects such as nonlocality, electronic spill-out/spill-in, and surface-enabled Landau damping (i.e., electron-hole pair generation), while also including retardation. Rooted on the Feibelman *d*-parameter formalism [1,3], we derive analytical expressions for the quantum-informed, nonclassical scattering coefficients, $\{r^{TM}, r^{TE}\}$ for the planar interface and $\{a_l^{TM}, b_l^{TE}\}$ for a metal sphere, from which we fully characterize the systems' plasmonic excitations and related nanophotonic phenomena governed by plasmon-empowered light–matter interaction. In particular, we investigate the role of the aforementioned quantum corrections to plasmon–emitter interactions, including the spectral reshaping of the local density of electromagnetic states (LDOS), the modification of dipole-forbidden transitions, and plasmon-mediated energy transfer between two emitters.

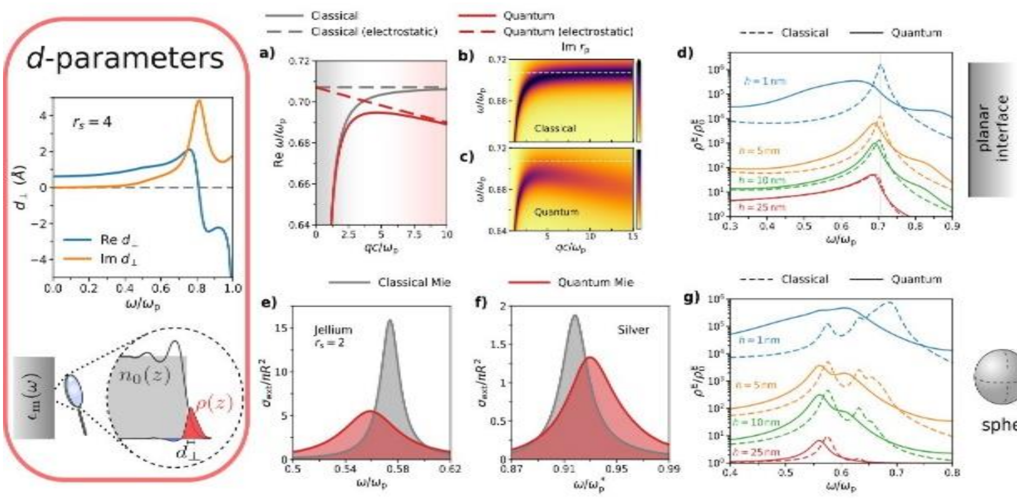

Figure *Illustration of the d-parameters calculated from TDDFT for an r_s=4 jellium, and representation of the quantum mechanical induced charge density in response to an external potential. a) Classical and quantum plasmon dispersion and b-c)* Im r^{TM} *for a planar dielectric–metal interface. Classical and quantum extinction cross-sections for a e) jellium and f) silver sphere. Classical and quantum LDOS enhancement for dipoles at different emitter–metal separations: d) planar interface; g) R=5 nm jellium sphere.*

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Soft-matter Platforms for Quantum Photonic Technologies at Nanoscale

C. Estevez-Varela(1), S. Holder(2), M. Lopez-García(3), J. Perez-Juste(1),
I. Pastoriza-Santos(1), S. Núñez-Sánchez(1)
(1) Departamento de Química Física & CINBIO, Universidade de Vigo, Spain.
(2) Quantum Engineering Technology Labs, School of Physics, University of Bristol, Bristol, U.K.
(3) Nanophotonics Dept, International Iberian Nanotechnology Laboratory, 4715-330 Braga, PT.

Mass production of on-chip quantum photonic technologies requires low-cost integration of devices at the nanometer scale. Presently photonic components are made of 'passive' structures such as optical fibres and are limited in how small components can be made (several microns). More recently gold and silver photonic components have been proposed as building blocks for nano-scale on-chip integration. A variety of alternative materials have been explored, including doped semiconductors, graphene or transparent conducting oxides. [1, 2] Here we present an exciting alternative to plasmonics: an organic quantum material which could confine the light at the nanoscale, like metals, but with more lower cost and taking the advantages of soft-matter and supramolecular chemistry to design properties on demand. [3]

The organic quantum material under study is formed by J-aggregates randomly distributed in a polymer matrix. The J-aggregates are supramolecular structures where strong electronic interactions between closer molecules results in the delocalization of Frenkel excitons over two or more molecules. As a consequence, we can define a quantum wave function over the collective system with a particular pattern of amplitudes across the molecules, equivalent to an extended state. These extended and delocalized Frenkel excitons bring extreme dielectric permittivity values to the polymer thin films, giving rise to high reflectivity and achieving negative real electric permittivity as metals but in a narrow wavelength range as it happens in 2D-excitonic materials. [1, 4] This extraordinary and narrow metal-like properties (Figure 1) could be used not just to confine light at nanoscale as in plasmonics, it also can be used as a tool in photonic design defining new types of optical modes. [5]

In this contribution I will show that these organic quantum materials can be used as building blocks at nanoscale. First, I will demonstrate that plasmon-like properties of molecular thin films can be obtained for a large variety of molecular J-aggregates with metal-like properties expanded from the VIS to the NIR. I will continue explaining how their intriguing properties such as spontaneous and reversible self-assembly can be used to master the properties of a quantum solid from the mesoscale. And, finally, I will show how colloidal chemistry approaches for nanofabrication can bring us to novel plastic quantum material platform at nanoscale.

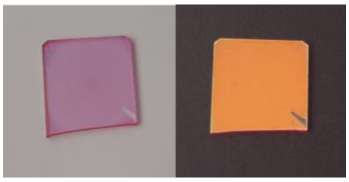

Figure 1.- *Picture of a J-aggregate thin film deposited on top of a glass and located on top of a white (left) and black (right) paper. The reflected color shows a strong metal-like band in the orange.*

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Determination of the optimal distribution for loading cargo vehicles using the IBM Qiskit VQE algorithm

Rafael Sotelo(1), Robert Loredo(2), Gerardo Beltrame(1), Martín Machín(1), Joaquín Fernández-Ojeda(1), Diego Gibert(1), Juan-Diego Orihuela(1), Ignacio Méndez(1), José-Pedro Algorta(1), Maximiliano Stock(1)
(1) Universidad de Montevideo, Montevideo, Uruguay.
(2) Florida International University, Miami, FL, USA.

A frequent problem amongst various transportation companies is determining the optimal loading strategy for packing their merchandise in different vehicles, such as boats, aircrafts, trains or trucks. This project aims at determining the optimal configuration of maximizing the loading of cargo vehicles –subject to appropriate constraints-- using quantum algorithms.
The problem, succinctly, can be stated as follows:
Let there be N packages to be transported. Each package *i*, has a weight w_i and a volume v_i. The vehicle has a maximum load capacity M and a maximum volume V.
The objective is to identify the optimal selection of the individual packages to be transported that maximizes the weight transported in each trip, subject to the load and volume constraints of the given vehicle.
Given the exponential increase in the number of possible combinations as N increases, the problem poses a serious challenge to be solved by classical means.
Our approach is based on the use of the IBM Qiskit Variational Quantum Eigensolver (VQE) algorithm [1,2,3,4,5].
Part of this work aims at understanding the complexity of classical computational methods to address fairly common problems, and the quantum advantage provided by the Variational Quantum Eigensolver (VQE) in order to propose a hybrid approach solution.
Based on the complexity order of a given problem (N, M, V) we will indicate the number of Qubits necessary to solve the problem, and the feasibility of running the algorithm in a quantum computer currently available or in the near future.
The final presentation will include the detailed strategy of the algorithm, the preparation of the initial quantum states and some sample cases.

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Authors:

Rafael Sotelo (rsotelo@um.edu.uy), Gerardo Beltrame (gbeltrame@um.edu.uy), Martín Machín (mmachin@correo.um.edu.uy), Joaquín Fernández-Ojeda (jsfernandez@correo.um.edu.uy), Diego Gibert (dgibert1@correo.um.edu.uy), Juan-Diego Orihuela (jorihuela@correo.um.edu.uy), Ignacio Méndez (jmendez@correo.um.edu.uy), José-Pedro Algorta (jpalgorta@correo.um.edu.uy) and Maximiliano Stock (mstock@correo.um.edu.uy) are with Universidad de Montevideo, from Montevideo, Uruguay.

Robert Loredo (loredo@us.ibm.com) adjunct professor, Florida International University, Miami, FL, USA.

Quantum computation from fermionic anyons on a one-dimensional lattice

Allan D. C. Tosta [1], Daniel J. Brod[1], Ernesto F. Galvão [1]
(1) Instituto de Física, Universidade Federal Fluminense, Av. Gal. Milton Tavares de Souza s/n, Niterói, Rio de Janeiro, 24210-340, Brazil

Fermionic linear optics corresponds to the dynamics of free fermions and is known to be efficiently simulable classically. We define fermionic anyon models by deforming the fermionic algebra of creation and annihilation operators, and consider the dynamics of number-preserving, quadratic Hamiltonians on these operators. We show that any such deformation results in an anyonic linear-optical model which allows for universal quantum computation.

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