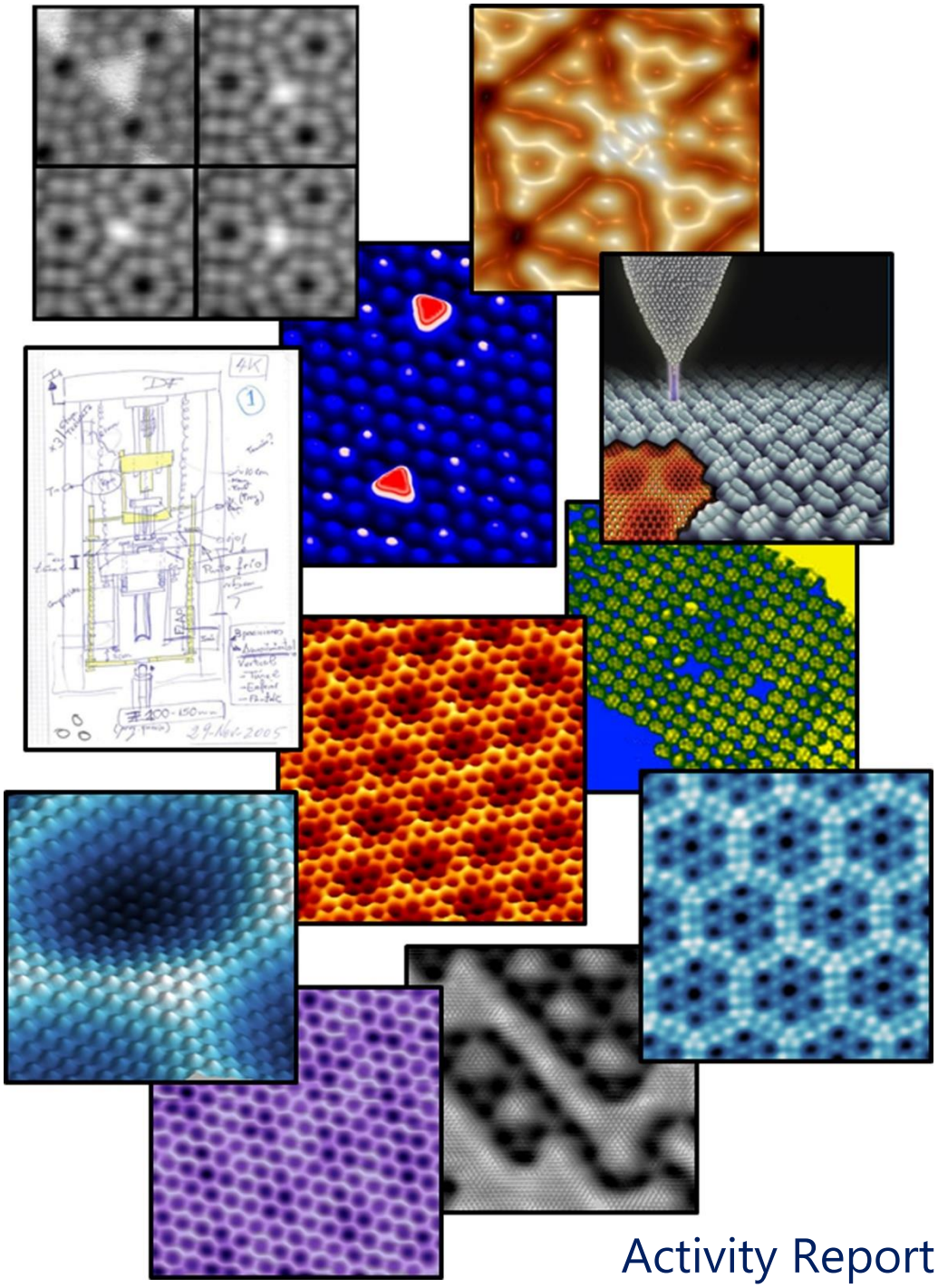
Nicolás Cabrera University Institute of Materials Science



Activity Report 2020

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INC Instituto Nicolás Cabrera

FACULTAD DE CIENCIAS

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Cover: Óscar, Iván, Nicoleta, Miguel, Antonio,
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Composed of STM images from each thesis supervised by
Professor José María Gómez-Rodríguez, chosen by his PhD students.

Nicolás Cabrera
University Institute
of Materials Science

ACTIVITY REPORT 2020

Edited by Isabel J. Ferrer in April 2021

UAM | Instituto Nicolás Cabrera

CONTENT

Foreword

Dear INC members, dear colleagues:

This is the first time that I have to present the activity report of the Institute of Materials Science "Nicolás Cabrera" (INC), where I take the opportunity to share some information and reflections.

The past year 2020 has probably been one of the hardest in a long time for the whole world, due to the pandemic that we still suffer. It will be a year that we will not forget. But, among other more important things, it has also been a year in which the leadership of the INC had to be renewed through elections at the end of July, which have led me to the responsibility and honour of being its new director. A double honour: First of all, for being a university institute that bears the name of Don Nicolás Cabrera (1913-1989), an essential figure in physics in Spain and whom I was hardly lucky enough to be able to see in a couple of times already in his later years. On the other hand, the honour of directing an institute that includes more than 100 prestigious professors and Ph.D. researchers within the generic area of Materials Science, surrounded by a large number of young researchers who carry out their doctoral theses in our research groups.

If the honour of the position is double, I would say that the beginning of this new task has also been double hard. On the one hand, being in charge of this important institute imposes respect on any rookie director, though I must thank the previous director, Prof. Hermann Suderow, for his help in making the transition as “smooth” as possible. On the other hand and above all, how hard it has been to start this new period having to give up many of the activities that are the essence of our institute and that by their very nature make sense only in person. In the first place, our famous and prestigious International Summer Schools, financed since 2002 by the BBVA Foundation, although they had already been held annually and uninterruptedly since 1994, with Prof. Sebastián Vieira then being the director. (I fondly remember the 4th edition that I daringly organized almost alone). What was to be its 27th edition last year obviously had to be postponed, not cancelled, as detailed below in this report. Moreover, since March 2020 the INC Colloquia in which researchers of great international recognition visited us, also sponsored by the FBBVA, were interrupted. Another flagship of our institute, the INC's Young Researchers Day, traditionally held in La Cristalera before Christmas, had to be held this year in a virtual and reduced format. However, I am fully confident that very soon we will be able to resume these core activities of the INC and to do so in its very missed face-to-face format.

On November 1, we received the sad news of the death of an active member of our institute, Prof. José María (Chema) Gómez-Rodríguez, who was an example of dedication to scientific research, training, and teaching. In addition, Chema was one of the organizers in 2014 of the XXI International Summer School “Nicolás Cabrera”, with the title “New frontiers in Scanning Force Microscopy: from ultrahigh-vacuum to biological material”. The cover of this report has been composed of images from each of the theses that he supervised, chosen by his PhD students. Nor do we forget the former member of the INC, Juan José Sáenz (Mole), who previously died also in 2020, although this was already mentioned in the previous edition of the INC's activity report.

In addition to the aforementioned scientific dissemination activities, the institute promotes, as is known, synergies in teaching and research activities. Our masters have been less affected than other activities of the institute, fortunately, undoubtedly thanks to the priceless effort and dedication of our professors and students. The investigation has not stopped either. In this report, as in previous editions, the list of publications detected with the affiliation of the INC is presented. By the way, let's not forget in the affiliations of our articles to include Institute "Nicolás Cabrera", Universidad Autónoma de Madrid. In addition to being an obligation of INC members according to the Internal Regulations of UAM institutes and research centres, this automatically allows (except for errors or omissions) that they appear visible on the front page of the INC website and in the activity reports such as this one. Likewise, a selection, necessarily incomplete and surely unfair, of outstanding articles from those INC publications is shown below. In addition to several works published in top-level journals, I want to emphasize that, of the nearly 90 articles published with the INC affiliation in 2020, a third have been published in Physical Review in any of its variants. Furthermore, I emphasize it because there are many of us who think that these publications are and should continue to be a reference for advanced research in physics, beyond other more striking publications or with high nominal impact factors.

One of the most pleasant experiences of these first months as director of INC was the occasion to give our awards to six physics students for their initiation research work, funded by the four departments that made up the INC, in addition to IFIMAC, to whom we sincerely thank for their contribution.

The generous and unconditional support of the people who agreed to join the INC Board with me (Isabel Jiménez Ferrer and Juan Aragonés), as well as those who agreed to form part of the new Steering Committee (Mª Dolores Martín, Iván Brihuega, Carmen Morant and Enrique Velasco), has also been very comforting. All of them were my first choice, no one refused to collaborate nor force me to look for someone else instead. Thank you!

Finally, and looking to the future, the Institute is currently immersed in a process of renewal and updating following the approval this past year by the Governing Council of the UAM of a new regulation for university institutes and research centres. This is naturally being one of the main tasks of the new INC Board. Apart from the legal and administrative obligations, we hope that this renewal will mean a before and after in the INC's framework within the university and its necessary financial support, through the elaboration of program-contracts with the vice-rector for research that shall allow the expansion of activities and initiatives of our institute, beyond the specific activities sponsored by the FBBVA. I look forward to sharing more information and good news about it in the next activity report.

To conclude, my final sincere thanks to all of you who make the INC possible with your participation in any area of our work.

Miguel Ángel Ramos

INC Director

Nicolás Cabrera Summer School

The **"Nicolás Cabrera" International Summer School** is celebrated annually since 1994 and its organization has been supported by the Fundación BBVA since 2002.

This year 2020 the XXVII Nicolás Cabrera School was to be held under the title**: "Physics of Biological Systems: From Emergent Collective behaviors to Functional Materials"** organized by Juan L. Aragonés (Dept. of Theoretical Condensed Matter Physics, INC, UAM), Laura R. Arriaga (Dept. of Theoretical Condensed Matter Physics, INC, UAM) and Raúl Guantes (Dept. of Condensed Matter Physics, INC, UAM) and scheduled for September 2020. However, it could not be held due to the health situation caused by the pandemic. **Its celebration has been postponed until spring 2022.**

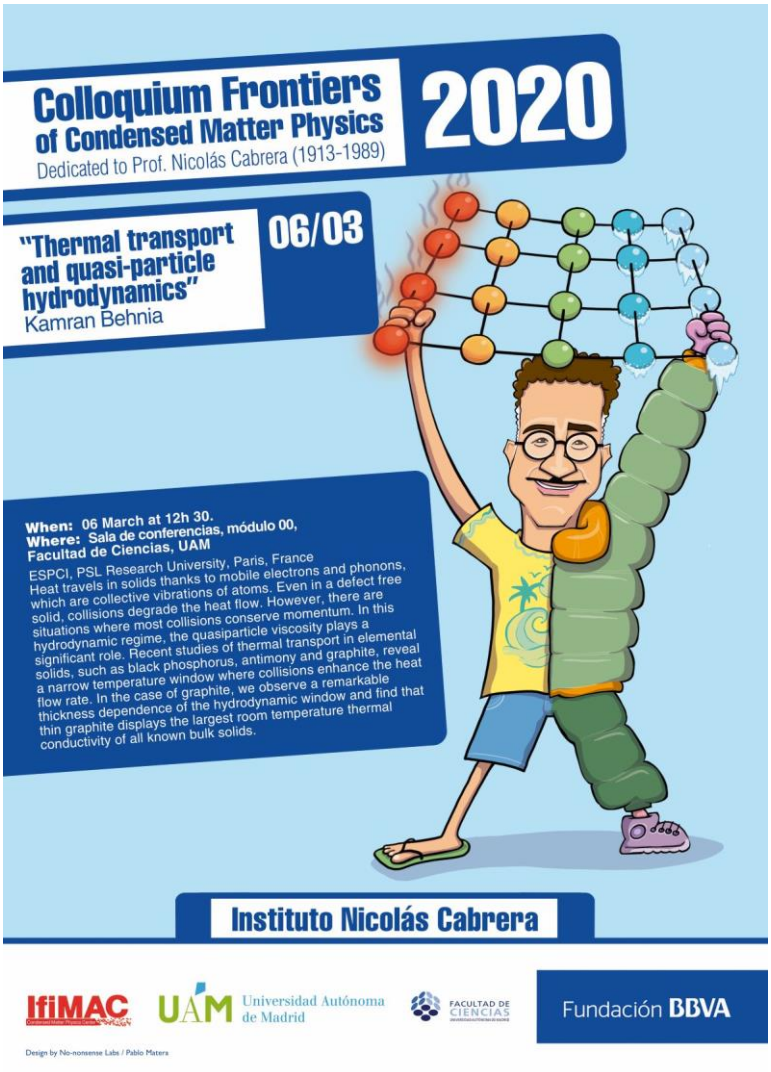
Two other scheduled Schools, in principle, keep their dates:

Ultrastable Glasses: New perspectives for an old problem, organized by Miguel Ángel Ramos (Dept. of Condensed Matter Physics, INC, UAM) and Javier Rodríguez-Viejo (Dept. of Physics, UAB) will be held predictably in September 2021.

Nearly atmospheric pressure/environmental characterization with electron/ion techniques and their application to catalytic, energy and biomedical systems, organized by Virginia Pérez Dieste (ALBA synchrotron, Barcelona), Dmitri Petrovykh, (International Iberian Nanotechnology Laboratory, INL, Braga) and Miguel Manso Silván (Dept. of Applied Physics, INC, UAM) is scheduled to take place in September 2022.

Colloquia

During 2020 only one of those colloquia previously programmed in the cycle of conferences "Frontiers of Physics of Condensed Matter", in collaboration with FBBVA and dedicated to Professor Nicolás Cabrera, could be carried out. The speaker, **Kamran Behnia,** who was chosen due to the significance of his activities and projection, talked about **"**Thermal transport and quasi-particle hydrodynamics".

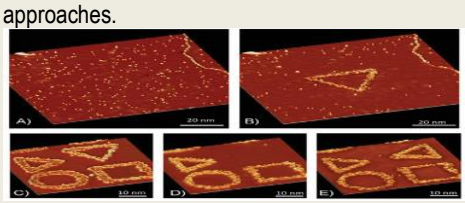


Science at INC

The articles of the INC are found on the website of the Institute. We mention below some publications that we wanted to highlight for their relevance. However, the complete list of INC articles published in 2020 is offered in a later section of this Report.

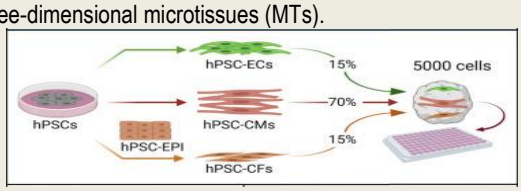
Quantum Confinement of Dirac Quasiparticles in Graphene Patterned with Sub-Nanometer Precision. E. Cortés-del Río, P. Mallet, H. González-Herrero, J.L. Lado, J. Fernández-Rossier, J.M. Gómez-Rodríguez, J. Y. Veuillen, I. Brihuega. **Advanced Materials 32**, 2001119 (Jun 2020).

Quantum confinement of graphene Dirac-like electrons in artificially crafted nanometer structures is a long sought goal that would provide a strategy to selectively tune the electronic properties of graphene, including bandgap opening or quantization of energy levels. However, creating confining structures with nanometer precision in shape, size, and location remains an experimental challenge, both for top-down and bottom-up approaches.



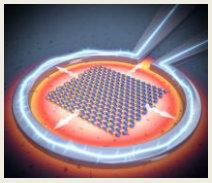
Human-iPSC-Derived Cardiac Stromal Cells Enhance Maturation in 3D Cardiac Microtissues and Reveal Non-cardiomyocyte Contributions to Heart Disease. E. Giacomelli, V. Meraviglia, G. Campostrini… D.G. Míguez, M. Ledesma-Terrón, et al. **Cell Stem Cell 26**, 862 (May 2020).

Cardiomyocytes (CMs) from human induced pluripotent stem cells (hiPSCs) are functionally immature, but this is improved by incorporation into engineered tissues or forced contraction. Here, we showed that tricellular combinations of hiPSC-derived CMs, cardiac fibroblasts (CFs), and cardiac endothelial cells also enhance maturation in easily constructed, scaffold-free, three-dimensional microtissues (MTs).



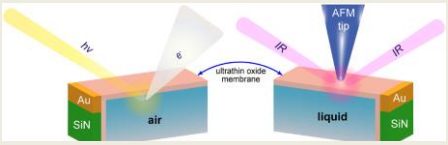
Microheater Actuators as a Versatile Platform for Strain Engineering in 2D Materials. Y.K. Ryu, F. Carrascoso, R. López-Nebreda, N. Agrait, R. Frisenda, A. Castellanos-Gómez. **Nano Letters 20**, 5339 (Jun 2020).

We present microfabricated thermal actuators to engineer the biaxial strain in two-dimensional (2D) materials. These actuators are based on microheater circuits patterned onto the surface of a polymer with a high thermal expansion coefficient. By running current through the microheater one can vary the temperature of the polymer and induce a controlled biaxial expansion of its surface.



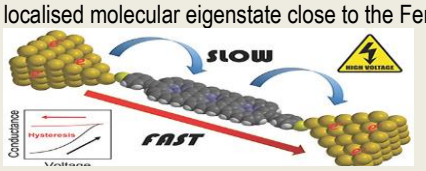
Ultrathin Free-Standing Oxide Membranes for Electron and Photon Spectroscopy Studies of Solid-Gas and Solid-Liquid Interfaces. Y.H. Lu, C. Morales, X. Zhao, M.A. van Spronsen, L. Soriano, et al. **Nano Letters 20**, 6364 (Aug 2020).

Free-standing ultrathin (~2 nm) films of several oxides (Al_2O_3,TiO_2, and others) have been developed, which are mechanically robust and transparent to electrons with $E_{kin} \geq 200$ eV and to photons. We demonstrate their applicability in environmental X-ray photoelectron and infrared spectroscopy for molecular level studies of solid−gas (≥1 bar) and solid−liquid interfaces. These films act as membranes closing a reaction cell and as substrates and electrodes for electrochemical reactions.



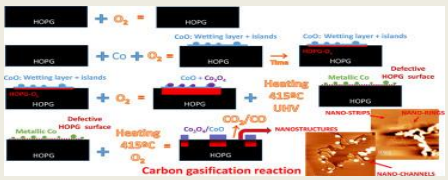
Long-lived charged states of single porphyrin-tape junctions under ambient conditions. E. Leary, G. Kastlunger, B. Limburg, L. Rincón-García, J. Hurtado-Gallego, G. Rubio Bollinger, N. Agrait, et al. **Nanoscale Horizons** 10.1039 (Oct 2020).

The ability to control the charge state of individual molecules wired in two-terminal single-molecule junctions is a key challenge in molecular electronics, particularly in relation to the development of molecular memory and other computational componentry. Here we demonstrate that single porphyrin molecular junctions can be reversibly charged and discharged at elevated biases under ambient conditions due to the presence of a localised molecular eigenstate close to the Fermi edge of the electrodes.



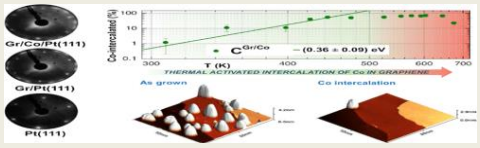
In-situ study of the carbon gasification reaction of highly oriented pyrolytic graphite promoted by cobalt oxides and the novel nanostructures appeared after reaction. C. Morales, D. Díaz-Fernández, P. Prieto, Y.H. Lu, H. Kersell, L. Soriano, et al. **Carbon 158,** 588, (Mar 2020).

Cobalt interaction and its effects on carbon-based systems at the nanoscale have recently attracted much attention in different fields, such as catalysis of carbon nanotubes or graphene and graphite nanopatterning taking advantage of its ferromagnetic behavior. Experiments performed in our laboratories show how the re-oxidation process of two equivalent monolayers of CoO deposited on highly oriented pyrolytic graphite at 400 degrees C leads to the formation of nanochannels at lower temperature than using other methods.



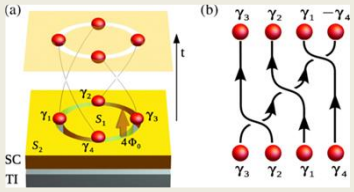
Thermally Activated Processes for Ferromagnet Intercalation in Graphene-Heavy Metal Interfaces. F. Ajejas, A. Anadon, A. Gudin, J.M. Diez, C.G. Ayani, A. Gutiérrez, F. Calleja, A. Vázquez de Parga, R. Miranda, J. Camarero, et al. **ACS Applied Materials & Interfaces 12**, 4088 (Jan 2020).

The development of graphene (Gr) spintronics requires the ability to engineer epitaxial Gr heterostructures with interfaces of high quality, in which the intrinsic properties of Gr are modified through proximity with a ferromagnet to allow for efficient room temperature spin manipulation or the stabilization of new magnetic textures. These heterostructures can be prepared in a controlled way by intercalation through graphene of different metals.



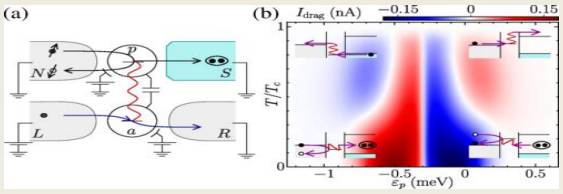
Electron-Tunneling-Assisted Non-Abelian Braiding of Rotating Majorana Bound States. S. Park, H.S. Sim, and P. Recher. **Phys. Rev. Lett. 125,** 187702 (Oct 2020).

It has been argued that fluctuations of fermion parity are harmful for the demonstration of non-Abelian anyonic statistics. Here, we demonstrate a striking exception in which such fluctuations are actively used. We present a theory of coherent electron transport from a tunneling tip into a Corbino geometry Josephson junction where four Majorana bound states (MBSs) rotate.



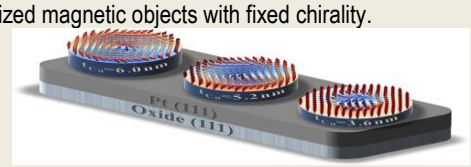
Andreev-Coulomb Drag in Coupled Quantum Dots. S.M. Tabatabaei, D. Sánchez, A. Levy Yeyati, R. Sánchez. **Phys. Rev. Lett. 125,** 247701 (Dec 2020).

The Coulomb drag effect has been observed as a tiny current induced by both electron-hole asymmetry and interactions in normal coupled quantum dot devices. In the present work we show that the effect can be boosted by replacing one of the normal electrodes by a superconducting one.



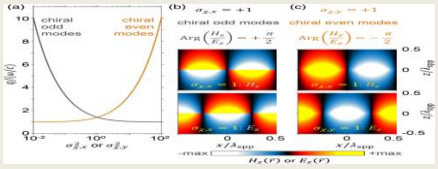
Intrinsic Mixed Bloch-Neel Character and Chirality of Skyrmions in Asymmetric Epitaxial Trilayers. P. Olleros-Rodríguez, R. Guerrero, J. Camarero, O. Chubykalo-Fesenko, P. Perna. **ACS Applied Materials & Interfaces 12**, 25419 (May 2020).

Recent advances in the stabilization and manipulation of chiral magnetization configurations in systems consisting of alternating atomic layers of ferromagnetic and nonmagnetic materials hold promise for innovation in spintronics technology. The low dimensionality of the systems promotes spin orbit driven interfacial effects like antisymmetric Dzyaloshinskii-Moriya interactions (DMI) and surface magnetic anisotropy, whose relative strengths may be tuned to achieve stable nanometer sized magnetic objects with fixed chirality.



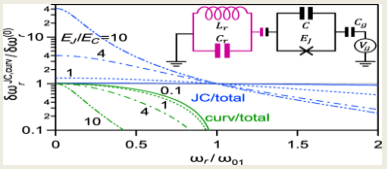
Chiral Plasmons with Twisted Atomic Bilayers. X. Lin, Z. Liu, T. Stauber, G. Gómez-Santos, F. Gao, H. Chen, B. Zhang, T. Low. **Phys. Rev. Lett. 125,** 077401 (Aug 2020).

van der Waals heterostructures of atomically thin layers with rotational misalignments, such as twisted bilayer graphene, feature interesting structural moiré superlattices. Because of the quantum coupling between the twisted atomic layers, light-matter interaction is inherently chiral; as such, they provide a promising platform for chiral plasmons in the extreme nanoscale.



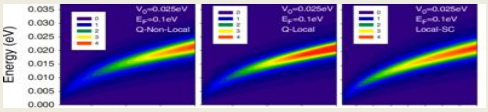
From Adiabatic to Dispersive Readout of Quantum Circuits. S. Park, C. Metzger, L. Tosi, M. F. Goffman, C. Urbina, H. Pothier, A. Levy Yeyati. **Phys. Rev. Lett. 125,** 077701(Aug 2020).

Spectral properties of a quantum circuit are efficiently read out by monitoring the resonance frequency shift it induces in a microwave resonator coupled to it. When the two systems are strongly detuned, theory attributes the shift to an effective resonator capacitance or inductance that depends on the quantum circuit state. At small detuning, the shift arises from the exchange of virtual photons, as described by the Jaynes-Cummings model. Here we present a theory bridging these two limits and illustrate, with several examples, its necessity for a general description of quantum circuits readout.



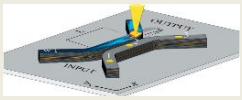
Nonlocal Quantum Effects in Plasmons of Graphene Superlattices. L. Brey, T. Stauber, L. Martín-Moreno, and G. Gómez-Santos. **Phys. Rev. Lett. 124,** 257401 (Jun 2020).

By using a nonlocal, quantum mechanical response function we study graphene plasmons in a one-dimensional superlattice (SL) potential $V_0 \cos G_0 x$. The SL introduces a quantum energy scale $E_G \sim \hbar v_F G_0$ associated with electronic subband transitions. At energies lower than E_G, the plasmon dispersion is highly anisotropic; plasmons propagate perpendicularly to the SL axis, but become damped by electronic transitions along the SL direction. These results question the validity of semiclassical approximations for describing low energy plasmons in periodic structures.



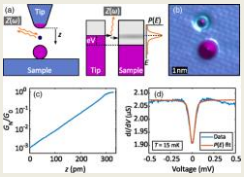
Impact of the Energetic Landscape on Polariton Condensates' Propagation along a Coupler. E. Rozas, J. Beierlein, M.D. Martín, L. Viña et al. **Advanced Optical Materials 8**, 2000650 (Jul 2020).

Polariton condensates' propagation is strongly dependent on the particular energy landscape the particles are moving upon, in which the geometry of the pathway laid for their movement plays a crucial role. Bends in the circuit's trajectories affect the condensates' speed and oblique geometries introduce an additional discretization of the polaritons' momenta due to the mixing of short and long axis wavevectors on the propagating eigenvalues. In this work, the nature of the propagation of condensates along the arms of a polariton coupler is studied by a combination of time-resolved micro-tomography measurements and a theoretical model based on a mean field approximation where condensed polaritons are described by an equation for the slow varying amplitude of the polariton field coupled to an equation for the density of incoherent excitons.



Dynamical Coulomb Blockade as a Local Probe for Quantum Transport. J. Senkpiel, J.C. Klöckner, M. Etzkorn, A. Levy Yeyati, J. C. Cuevas, et al. **Phys. Rev. Lett. 124,** 156803 (Apr 2020).

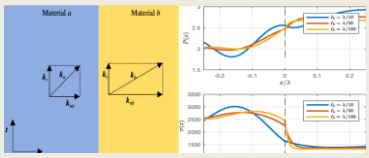
Quantum fluctuations are imprinted with valuable information about transport processes. Experimental access to this information is possible, but challenging. We introduce the dynamical Coulomb blockade (DCB) as a local probe for fluctuations in a scanning tunneling microscope (STM) and show that it provides information about the conduction channels. In agreement with theoretical predictions, we find that the DCB disappears in a single-channel junction with increasing transmission following the Fano factor, analogous to what happens with shot noise.



Generalized elastodynamic model for nanophotonics. J. V. Alvarez, B. Djafari-Rouhani, and D. Torrent. **Phys. Rev. B 102**, 115308 (Sep 2020).

A self-consistent theory for the classical description of the interaction of light and matter at the nanoscale is presented, which takes into account spatial dispersion. Up to now, the Maxwell equations in nanostructured materials with spatial dispersion have been solved by the introduction of the so-called additional boundary conditions which, however, lack generality and uniqueness. In this paper, we derive an approach where nonlocal effects are studied in a precise and uniquely defined way, thus allowing the treatment of all solid-solid interfaces (among metals, semiconductors or insulators), as well as solid-vacuum interfaces in the same framework.

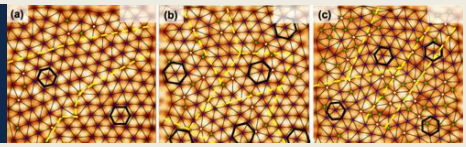
PHYSICAL REVIEW B



Disordered hyperuniformity in superconducting vortex lattices. J.B. Llorens, I. Guillamón, I.G. Serrano, S. Vieira, M. Ortuño, H. Suderow et al. **Phys. Rev. Research 2**, 033133 (July 2020).

The current carrying capability of type II superconductors under magnetic fields is determined to a large extent by the interaction of superconducting vortices with pinning centers. Vortices are arranged in lattices with varying degrees of disorder depending on the balance between the intervortex interactions and the pinning strength. We analyze here vortex arrangements in disordered vortex lattices of different superconducting systems, single crystals (Co-doped NbSe2, LiFeAs, and CaKFe4As4), and amorphous W-based thin films (with critical temperatures Tc from 4 K to 35 K and critical fields from 3.4 T to more than 90 T).

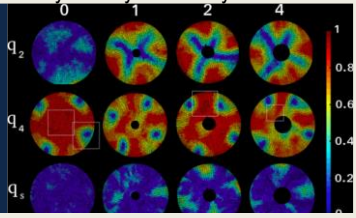
PHYSICAL REVIEW RESEARCH



Domain walls in vertically vibrated monolayers of cylinders confined in annuli. A. Díaz-De Armas, M. Maza-Cuello, Y. Martínez-Ratón, E. Velasco. **Phys. Rev. Research 2,** 033436 (Sep 2020)

Liquid-crystalline ordering in vertically vibrated granular monolayers of metallic rods confined in annuli of different sizes is examined. The annuli consist of circular cavities with a central circular obstruction. In the absence of the central obstruction, rods of low aspect ratio exhibit global tetratic order, except for the existence of four small defected regions which restore the tetratic symmetry broken by the circular confinement.

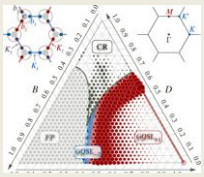
PHYSICAL REVIEW RESEARCH



Novel Chiral Quantum Spin Liquids in Kitaev Magnets. A. Ralko, J. Merino. **Phys. Rev. Lett. 124,** 217203 (May 2020).

Quantum magnets with pure Kitaev spin exchange interactions can host a gapped quantum spin liquid with a single Majorana edge mode propagating in the counterclockwise direction when a small positive magnetic field is applied. Here, we show how under a sufficiently strong positive magnetic field a topological transition into a gapped quantum spin liquid with two Majorana edge modes propagating in the clockwise direction occurs. The Dzyaloshinskii-Moriya interaction is found to turn the nonchiral Kitaev's gapless quantum spin liquid into a chiral one with equal Berry phases at the two Dirac points.

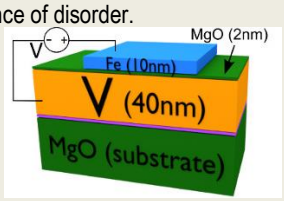
Physical Review Letters
moving physics



Interfacial Spin-Orbit Coupling: A Platform for Superconducting Spintronics. I. Martínez, P. Högl, C. González-Ruano, F. G. Aliev, et al. **Phys. Rev. Applied 13,** 014030 (Jan 2020).

Spin-orbit coupling (SOC) is a key interaction in spintronics, allowing electrical control of spin or magnetization and, vice versa, magnetic control of electrical current. However, recent advances have revealed much broader implications of SOC that is also central to the design of topological states with potential applications from low-energy dissipation and faster magnetization switching to high tolerance of disorder.

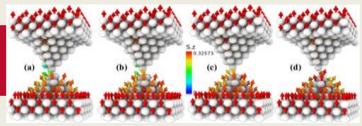
PHYSICAL REVIEW APPLIED



Refined electron-spin transport model for single-element ferromagnetic systems: Application to nickel nanocontacts. W. Dednam, C. Sabater, O. Tal, J. J. Palacios, A. E. Botha, and M. J. Caturla. **Phys. Rev. B 102,** 245415 (Dec 2020)

Through a combination of atomistic spin-lattice dynamics simulations and relativistic *ab initio* calculations of electronic transport we shed light on unexplained electrical measurements in nickel nanocontacts created by break junction experiments under cryogenic conditions (4.2 K). We implement post-self-consistent-field corrections in the conductance calculations to account for spin-orbit coupling and the noncollinearity of the spins, resulting from the spin-lattice dynamics.

PHYSICAL REVIEW B



Young researchers meeting

The XXIII Young researchers meeting 2020, carried out on January 28, 2021 in an online format through the Zoom application, was organized by the current Steering Committee and structured in 4 Sessions after the Opening by the director of the Institute, Professor Miguel Ángel Ramos. Pre and postdoctoral researchers from the different departments contributed to the first two sessions. The third session, which was jointly organized with the Condensed Matter Physics Center (IFIMAC), consisted of an invited conference and the last one was dedicated to the award-winning students who presented their research in a short oral communication.

The program of the day is briefly exposed below:

SESSION I, chaired by Pilar Prieto Recio and with Iván Brihuega as Zoom host.

- "Performing deep-tissue photodynamic therapy with rare-earth-doped nanoparticles and Eosin Y"
  Gabriel López Peña (Applied Physics Dept.)
- "Nanojet trapping of a single sub-10 nm upconverting nanoparticle in the full liquid water temperature range"
  Dasheng Lu (Materials Physics Dept.)
- "Plasmonic Heating and Luminescence Thermometry: Developing an Optical Thermal Probe to Perform in Biological Environments"
  Marta Quintanilla (Materials Physics Dept.)
- "Hybrid nanostructures for applications in photonics: photovoltaic and light-sensing devices"
  Rehab Ramadan (Applied Physics Dept.)

SESSION II, chaired by Laura Rodríguez Arriaga and with Juan Aragonés as Zoom host.

- "Tunable proximity effects and topological superconductivity in semiconductor/superconductor/ferromagnetic hybrid nanowires "
  Samuel Díaz Escribano (Theoretical Condensed Matter Physics Dept.)
- "Topological phases induced by interactions and spin-orbit coupling in decorated honeycomb lattices"
  Manuel Fernández López (Theoretical Condensed Matter Physics Dept.)
- "Superconducting STM tip functionalized with a magnetic impurity to probe the transition from Yu-Shiba-Rusinov States to Kondo Screening"
  Cosme González Ayani (Condensed Matter Physics Dept.)
- "Simultaneous conductance and thermopower measurements in single-molecule junctions using a scanning tunnelling microscope"
  Laura Rincón García (Condensed Matter Physics Dept.)

SESION III, chaired by Laura Rodríguez Arriaga and with Juan Aragonés as Zoom host.

Invited conference of title, ***"Toroids, Active Nematics and Topological Defects"*** was given by Professor **Alberto Fernández-Nieves** (University of Barcelona & ICREA) simultaneously for the audience of the Series of joint Seminars organized by the Condensed Matter Physics Center (IFIMAC) and the Materials Science Institute (ICMM, CSIC).

SESSION IV, chaired by the director of the Institute, Miguel Ángel Ramos, and with Dolores Martín as Zoom host.

Presentation of the research work carried out by the students who received the award in this edition:

Miguel Calvo Carrera *"Transporte termoeléctrico en puntos cuánticos"*

Federico Martín Lucas *"Pulsed photon correlations under strong light-matter coupling in nanoplasmonic cavities"*

Daniel Molpeceres Mingo *"Topological Invariants in Disordered and Amorphous Systems from Neural Networks"*

Gonzalo Morrás Gutiérrez *"Transporte electrónico a través de impurezas magnéticas acopladas a superconductores"*

Ignacio Robles López *"Espectroscopia resuelta en tiempo en nanoestructuras semiconductoras"*

Andrea Ropero Real *"Modelling the transformation of zinc nitride metastable layers"*

The meeting took place throughout the morning and everyone agreed on the high level of the students and the good presentations they made.

Awards for undergraduate students

The Nicolás Cabrera Institute announced 6 awards financed by the departments of Condensed Matter Physics, Theoretical Condensed Matter Physics, Materials Physics and Applied Physics (one award each), and the Condensed Matter Physics Center, IFIMAC, (which subsidized 2 awards), to appeal to physics students towards research groups and to promote the Institute's scientific work.

The awarded students and research topics in which they participated are the following:

- Gonzalo Morrás Gutiérrez: "*Estudio teórico del transporte electrónico en nanoestructuras superconductoras*".
- Miguel Calvo Carrera: "*Thermal transport and topological superconductivity*"
- Daniel Molpeceres Mingo: "*Topological Invariants in Disordered and Amorphous Systems from Neural Networks*"
- Ignacio Robles López: *" Microcavidades de semiconductores como componentes para la información cuántica"*
- Federico Martín Lucas: *"Interacción luz-materia en cavidades nanofotónicas"*
- Andrea Ropero Real: "*Development of wearable IoT sensors to monitor body hydration"*

Publications

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Members (Doctors)

	RESEARCH-PROFESSOR	DEPARTMENT
1	Agraït de la Puente, Nicolás	CONDENSED MATTER PHYSICS
2	Agulló López, Fernando	MATERIALS PHYSICS
3	Aliev Kazanski, Farkhad	CONDENSED MATTER PHYSICS
4	Álvarez Alonso, Jesús	CONDENSED MATTER PHYSICS
5	Álvarez Carrera, José Vicente	CONDENSED MATTER PHYSICS
6	Aragó López, Carmen	MATERIALS PHYSICS
7	Aragones Gómez, Juan L.	THEORETICAL CONDENSED MATTER PHYSICS
8	Ares García, Pablo	CONDENSED MATTER PHYSICS
9	Arranz de Gustín, Antonio	APPLIED PHYSICS
10	Barandiarán Piedra, Zoila	CHEMISTRY
11	Bausá López, Luisa	MATERIALS PHYSICS
12	Bravo Roldán, David	MATERIALS PHYSICS
13	Brihuega Alvarez, Ivan	CONDENSED MATTER PHYSICS
14	Caballero Mesa, Raquel	APPLIED PHYSICS
15	Camarero de Diego, Julio	CONDENSED MATTER PHYSICS
16	Cantelar Alcaide, Eugenio	MATERIALS PHYSICS
17	Carrascosa Rico, Mercedes	MATERIALS PHYSICS
18	Carretero Palacios, Sol	MATERIALS PHYSICS
19	Cervera Goy, Manuel	APPLIED PHYSICS
20	Chacón Fuertes, Enrique	MATERIALS SCIENCE INSTITUTE OF MADRID (ICMM)-CSIC
21	Cinacchi, Giorgio	THEORETICAL CONDENSED MATTER PHYSICS
22	Cussó Pérez, Fernando	MATERIALS PHYSICS
23	De Miguel Llorente, Juan José	CONDENSED MATTER PHYSICS
24	De Pablo Gomez, Pedro José	CONDENSED MATTER PHYSICS
25	Delgado Buscalioni, Rafael	THEORETICAL CONDENSED MATTER PHYSICS
26	Díaz Palacios, Raquel	APPLIED PHYSICS
27	Farias Tejerina, Daniel	CONDENSED MATTER PHYSICS
28	Feist, Johannes	THEORETICAL CONDENSED MATTER PHYSICS
29	Fernández Cuñado, José Luis	CONDENSED MATTER PHYSICS
30	Fernández Dominguez, A. Isaac	THEORETICAL CONDENSED MATTER PHYSICS
31	Fernández Garrido, Sergio	APPLIED PHYSICS
32	Fernández Ríos, José Francisco	MATERIALS PHYSICS
33	Galán Estella, Luis	APPLIED PHYSICS
34	García Cabañes, Angel	MATERIALS PHYSICS
35	García Carretero, Basilio Javier	APPLIED PHYSICS
36	García Michel, Enrique	CONDENSED MATTER PHYSICS
37	García Solé, José	MATERIALS PHYSICS
38	García Vidal, Francisco José	THEORETICAL CONDENSED MATTER PHYSICS
39	Garrido Salas, Javier	ELECTRONICS AND COMMUNICATIONS TECHNOLOGY
40	Gómez Herrero, Julio	CONDENSED MATTER PHYSICS
41	Gómez Santos, Guillermo	CONDENSED MATTER PHYSICS
42	Gómez-Argüello Gordillo, Rocío	PAS - INC
43	Gómez-Navarro Gonzalez, Cristina	CONDENSED MATTER PHYSICS
44	Gordillo García, Nuria	APPLIED PHYSICS
45	Guantes Navacerrada, Raúl	CONDENSED MATTER PHYSICS

	RESEARCH-PROFESSOR	DEPARTMENT
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48	Haro González, Patricia	MATERIALS PHYSICS
49	Hernández Muñoz, María Jesús	APPLIED PHYSICS
50	Herrera Vasco, Edwin	CONDENSED MATTER PHYSICS
51	Jaafar Ruiz-Castellanos, Miriam	CONDENSED MATTER PHYSICS
52	Jaque García, Daniel	MATERIALS PHYSICS
53	Jiménez Ferrer, Isabel	MATERIALS PHYSICS
54	Lazic, Snezana	MATERIALS PHYSICS
55	Leardini, Fabrice	MATERIALS PHYSICS
56	Lee, Eduardo Jian Hua	CONDENSED MATTER PHYSICS
57	Levy Yeyati Mizrahi, Alfredo	THEORETICAL CONDENSED MATTER PHYSICS
58	Lifante Pedrola, Ginés	MATERIALS PHYSICS
59	Llombart González, Pablo	THEORETICAL CONDENSED MATTER PHYSICS
60	López Vázquez de Parga, Amadeo	CONDENSED MATTER PHYSICS
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64	Martín Fernández, María Dolores	MATERIALS PHYSICS
65	Martín Palma, Raúl José	APPLIED PHYSICS
66	Martín Rodríguez, Emma	APPLIED PHYSICS
67	Martínez Galera, Antonio Javier	MATERIALS PHYSICS
68	Merino Álvarez, José Manuel	APPLIED PHYSICS
69	Merino Troncoso, Jaime	THEORETICAL CONDENSED MATTER PHYSICS
70	Miguez Gómez, David	CONDENSED MATTER PHYSICS
71	Miranda Soriano, Rodolfo	CONDENSED MATTER PHYSICS
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75	Ortega Mateo, José	THEORETICAL CONDENSED MATTER PHYSICS
76	Palacios Burgos, Juan José	CONDENSED MATTER PHYSICS
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78	Pérez Casero, Rafael	APPLIED PHYSICS
79	Pérez Pérez, Rubén	THEORETICAL CONDENSED MATTER PHYSICS
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84	Prins, Ferry	CONDENSED MATTER PHYSICS
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86	Ramos Ruiz, Miguel Angel	CONDENSED MATTER PHYSICS
87	Redondo Cubero, Andrés	APPLIED PHYSICS
88	Rodrigo Rodríguez, José Gabriel	CONDENSED MATTER PHYSICS
89	Rodriguez Arriaga, Laura	THEORETICAL CONDENSED MATTER PHYSICS
90	Rubio Bollinger, Gabino	CONDENSED MATTER PHYSICS
91	Sánchez López, Carlos	MATERIALS PHYSICS
92	Sánchez Rodrigo, Rafael	THEORETICAL CONDENSED MATTER PHYSICS
93	Sanz García, Juan Antonio	MATERIALS PHYSICS
94	Sanz Martínez, José Mª	APPLIED PHYSICS
95	Segovia Cabrero, Pilar	CONDENSED MATTER PHYSICS

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99	Suderow Rodriguez, Hermann	CONDENSED MATTER PHYSICS
100	Tarazona Lafarga, Pedro	THEORETICAL CONDENSED MATTER PHYSICS
101	Tejedor de Paz, Carlos	THEORETICAL CONDENSED MATTER PHYSICS
102	Van der Meulen, Herko	MATERIALS PHYSICS
103	Velasco Caravaca, Enrique	THEORETICAL CONDENSED MATTER PHYSICS
104	Vieira Díaz, Sebastián	CONDENSED MATTER PHYSICS
105	Viña Liste, Luis	MATERIALS PHYSICS
106	Yndurain Muñoz, Félix	CONDENSED MATTER PHYSICS

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3	López Peña, Gabriel	APPLIED PHYSICS
4	Lu, Dasheng	MATERIALS PHYSICS
5	Magrinyá Aguiló, Paula	THEORETICAL CONDENSED MATTER PHYSICS
6	Moratalla Martín, Manuel Eduardo	CONDENSED MATTER PHYSICS
7	Naveas Ríos, Nelson Andrés	APPLIED PHYSICS
8	Ortiz Rivero, Elisa	MATERIALS PHYSICS
9	Pulido Venegas, Ruth Noemí	APPLIED PHYSICS
10	Ramadan Shehata, Rehab	APPLIED PHYSICS
11	Sánchez Barquilla, Mónica	THEORETICAL CONDENSED MATTER PHYSICS

Instituto Nicolás Cabrera

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