

Nicolás Cabrera University Institute of Materials Science



Activity Report 2021



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Instituto
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Cover image: "La Cristalera", UAM

Nicolás Cabrera
University Institute
of Materials Science

ACTIVITY REPORT 2021

Edited by Isabel J. Ferrer in March 2022



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Foreword

Dear INC members, dear colleagues:

We present here the annual Activity Report of the "Nicolás Cabrera" Institute corresponding to the year 2021. Compared to the previous year, I am pleased to highlight the return to the main activities of the Institute in face-to-face format, although still with precautions and limitations, carried out as always in La Cristalera (which is why it appears on the cover): the International Summer School was held in September after resuming the agreement with the BBVA Foundation, as well as the traditional Young Researchers Meeting in December. It is pending to recover the INC Colloquiums "Frontiers in Materials Science", which is expected to be carried out throughout 2022.

As in previous years, the Young Researchers Day was organized so that the physics students who were awarded for their academic records, presented their research work in poster format. One more year, we must thank the IFIMAC and the departments of Materials Physics, Applied Physics, Condensed Matter Physics and Theoretical Physics of Condensed Matter for funding these awards. But I want to highlight, above all, that the new "*Chema Gómez-Rodríguez Awards*" were also presented and delivered on that day to recognize the two best articles recently published by young INC researchers, chosen by our new Scientific Advisory Committee. In this first edition the prizes were financially supported by the Department of Condensed Matter Physics.

In the research section, this report includes a list of around a hundred publications in 2021 by the members of the Institute. In a separate section we highlight some of them according to the so-called impact factor of the journal. As explained there, only those with a factor above 9 have been collected, since having included all the articles published in high-level journals would have made it endless. I remember again that you should not forget to add in the affiliations of your articles the reference to the "Nicolás Cabrera" Institute, since otherwise they do not count for the memory report of the INC nor will they be given visibility on our website.

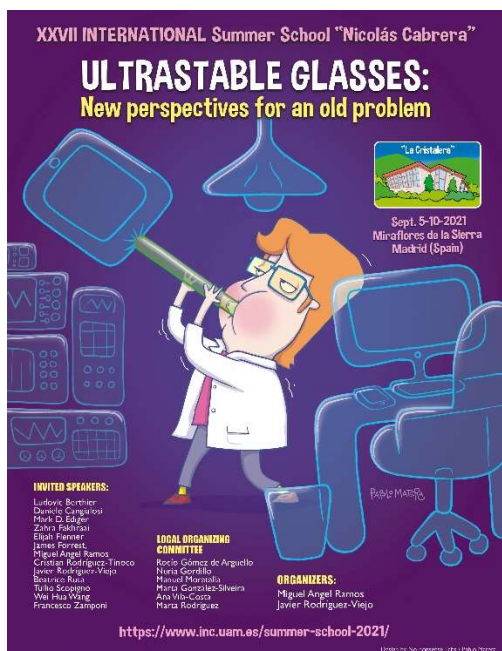
At the end of the report you can see the updated membership list of the Institute, comprising 80 permanent members and more than 50 other members. Also included this year for the first time is a summary of the economic balance. It certainly remains a challenge for this and the coming years to be able to access stable funding for the Institute from the UAM, beyond the specific agreements with the BBVA Foundation that we continue to achieve to finance the Summer School and the Colloquiums.

Finally, I would like to express my gratitude to all the members of the "Nicolás Cabrera" Institute for keeping the spirit of this initiative alive and active after almost thirty years, and my wishes that we can soon return to a certain "normality" both in the scientific and in the personal fields after these turbulent years.

Miguel Ángel Ramos
INC Director

“Nicolás Cabrera” Summer School

The XXVII “Nicolás Cabrera” International Summer School, organized by Miguel Angel Ramos y Javier Rodríguez-Viejo, was held during september 5-10, 2021 in Miraflores de la Sierra, under the title: “Ultrastable glasses: New perspectives for an old problem”.



The School was held at the UAM Residence "La Cristalera".

A total of 38 participants attended (13 women and 25 men) from 9 different countries, 12 of them were the speakers, and the rest were students and postdoctoral researchers.

The lectures covered the following topics:

- Kinetics and Thermodynamics: stability, enhanced surface diffusion, the origin of ultra-stability.
- Vapour deposition and molecular orientation in relation to stability and properties.
- Other high stability glasses (amber, other hyper-aged polymers and stabilized glasses).
- Applications of stable glasses, mainly OLEDs for organic glasses, others for metallic glasses.



Group photograph of 2021 Summer School at the Miraflores de la Sierra site.

The list of speakers who participated in the School and their affiliations is as follows:

- ✓ Ludovic Berthier, CNRS – Univ. Montpellier (France)
- ✓ Daniele Cangialosi, Centro de MATERIALS PHYSICS, San Sebastián (Spain)
- ✓ Mark D. Ediger, University of Wisconsin–Madison (USA)
- ✓ Zahra Fakhraei, University of Pennsylvania, Philadelphia (USA)
- ✓ Elijah Flenner, Colorado State University (USA)
- ✓ James Forrest, University of Waterloo (Canada)
- ✓ Miguel Angel Ramos, Universidad Autónoma de Madrid (Spain)
- ✓ Cristian Rodríguez-Tinoco, Universitat Autònoma de Barcelona (Spain)
- ✓ Javier Rodríguez-Viejo, Universitat Autònoma de Barcelona (Spain)
- ✓ Beatrice Ruta, CNRS – Université Lyon (France)
- ✓ Tullio Scopigno, Università “Sapienza”, Rome (Italy)
- ✓ Francesco Zamponi, CNRS – Ecole Normale Supérieure, Paris (France)



Inauguration in the presence of the Vice-Rector for Science Policy.



Poster session



Starting a session

The “Nicolás Cabrera” International Summer School has been celebrated annually since 1994 and the [Fundación BBVA](#) has supported its organization since 2002.

Fundación **BBVA**

Colloquia

No colloquium was held in 2021 due to the pandemic and the reduction of on-site activities.

Awards for undergraduate Physics students

The Nicolás Cabrera Institute announced six awards financed by the departments of Condensed Matter Physics, Theoretical Condensed Matter Physics, Materials Physics and Applied Physics (one prize each), and the Condensed Matter Physics Center, IFIMAC, (which subsidized two 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:

- Marcos Arranz Jiménez, trabajo: *“Caracterización estructural y electrónica de perovskitas quirales híbridas (estudio de la banda de valencia y formación de excitones)”*
- Sebastián De la Peña Ruiz, *“Magnon spin and energy transport”*
- Alejandro Lasso Castillo, *“Use and development of Machine Learning Force Fields in Solid State Physics”*
- Clara Galante Agero, *“Machine Learning Interpretability for Scientific Discovery in Condensed Matter Physics”*
- Francisco Javier Fernández Alonso, *“Deposición de electrodos impedimétricos sobre acero para el desarrollo de sensores embebidos”*
- Juan Lizarraga Lallana, *“Interacción entre condensados de polaritones en acopladores de microcavidades de semiconductor”*



CHEMA-GÓMEZ RODRÍGUEZ Awards for young researchers

The Institute has announced two "Chema Gómez-Rodríguez" awards, named after Professor José María Gómez Rodríguez and funded by the Condensed Matter Physics Department, to promote the excellent work of young scientists at the INC by recognizing their contributions in high-impact publications during the year 2021.

The following publications were selected::

1. Eva Cortés-del Rio et al, "Observation of Yu-Shiba-Rusinov States in Superconducting Graphene" *Adv. Mater.* 2021, 33, 2008113.
This work reports an important finding: the observation of YSR states in a structural defect (grain boundary) of a chemically pure system without the need for any magnetic impurity. This publication will strongly impact at least on two very active fields: 2D materials and mesoscopic superconductivity. Eva Cortés-del Rio carried out most of the experimental work, including the complex instrumental development, and participated in discussing the results and the writing of the paper. This work was published in a reference journal in the field of Materials.
2. Elisa Ortiz-Rivero, "Laser Refrigeration by an Ytterbium-Doped NaYF₄ Microspinner", *Small* 2021, 21003122.
This work presents an original and elegant way to cool a liquid and measure its temperature on the micrometer scale. Cooling is achieved by driving the anti-stokes ytterbium emission from an optically trapped microparticle and its damped rotational dynamics is used as an accurate local thermometer. This technique should have a significant impact on microfluidics with applications in biophysics. Elisa Ortiz-Rivero carried out most of the experimental work and participated in discussing the results and the article's writing.

The Commission responsible for the selection of the papers was formed by the INC's external Scientific Advisory Committee composed by [Alicia de Miguel](#) (ICMM – CSIC, Spain), [Akhlesh Lakhtakia](#) (Pennsylvania State University, USA), [Herre Van der Zant](#); (TU Delft, Netherlands) and [Cristian Urbina](#) (CEA – Saclay, CNRS, France).



Young researchers meeting



The XXIV "Nicolas Cabrera" young researchers' conference was held on 17 December 2021 in Miraflores de la Sierra, with the participation of PhD students from different Postgraduate Program. The meeting was a success with nearly 70 attendees, which was the maximum allowed for safety reasons against CoVid infections.

The **program for the day** was as follows:

The opening was led by the director of the Institute, Miguel Ángel Ramos.

Afterwards, the "Chema Gómez-Rodríguez" awards were given to the best research papers published this year by pre-doctoral researchers:

- **First prize: Eva Cortés del Río** for her work "Observation of Yu-Shiba-Rusinov States in Superconducting Graphene" carried out in collaboration with Jose Luis Lado, Vladimir Cherkez, Pierre Mallet, Jean-Yves Veuillen, Juan Carlos Cuevas, José María Gómez-Rodríguez, Joaquín Fernández-Rossier and Iván Brihuega. Published in *Advanced Materials* 33, 2008113 (2021).
- **Second prize: Elisa Ortiz Rivero** for her work "Laser Refrigeration by an Ytterbium-Doped NaYF₄ Microspinner", in collaboration with Katarzyna Prorok, Inocencio Rafael Martín, Radosław Lisiecki, Patricia Haro-González, Artur Bednarkiewicz, and Daniel Jaque. Published in *Small* 17, 21003122 (2021)

The **invited lecture** was given by **Dr. Gloria Platero**, Research Professor at the Institute of Materials Science of the CSIC, entitled: "Simulation of topological phases in quantum dot arrays".

Next, a selection of papers was presented by young researchers representative of the doctoral students associated with the Institute in the following order:

- **Nuria Jiménez Arévalo** "BCN coatings on TiO₂/TiS₃ heterostructures for electrolytic water splitting", (Materials Physics Department)
- **Alejandro José Uría Álvarez** "Deep learning for disordered topological insulators through entanglement spectrum", (Condensed Matter Physics Department)
- **Carlos Sebastián Vicente** "Light and Thermally Induced Charge Transfer and Ejection of Micro/Nanoparticles from Ferroelectric Crystal Surfaces" (Materials Physics Department)
- **Daniel Arribas** "On-Surface Dehydrogenation and Cyclisation of n-Octane (C₈H₁₈) on Pt(111)" (Applied Physics Department)

The last activity of the morning was the poster session in which 42 young researchers participated, including the awarded Physics students who showed the results of their research associated with the award:

- **Marcos Arranz Jiménez** “*Photovoltaic effects study on hybrid perovskites thin layers*”
- **Sebastián de la Peña Ruiz** “*Theory of drift-enabled control in nonlocal magnon transport*”
- **Alejandro Lasso Castillo** “*Density Functional Theory and Machine Learning techniques for the study of amorphous materials*”
- **Clara Galante Agero** “*Machine Learning in Nonlinear Dynamic Systems*”
- **Francisco Javier Fernández Alonso** “*Deposition of impedimetric electrodes on steel for the development of embedded sensors*”
- **Juan Lizarraga Lallana** “*Polariton condensation in semiconductor microcavity pillars*”

Finally, in the afternoon session, all the talks were given by students belonging to the Inter-University PhD Program in Condensed Matter Physics, Nanoscience and Biophysics.

- **Antonio Tiene** “The two-dimensional Fermi polaron problema” (Applied Physics Department, UAM)
- **Aitor Zambudio Sepúlveda** “Fine Defect Engineering of Graphene Friction” (University of Murcia)
- **Gonzalo Álvarez Pérez** “Refraction and lensing of nano-light in an anisotropic two-dimensional material” (Universidad de Oviedo)
- **Sergio Puebla** “In-plane anisotropic optical and mechanical properties of two-dimensional MoO₃” (ICMM – CSIC)
- **César González-Ruano** “Boosting Room Temperature Tunnel Magnetoresistance in Hybrid Magnetic Tunnel Junctions Under Electric Bias”, (Condensed Matter Physics Department, UAM)

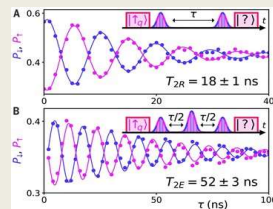


Science at INC

The INC articles can be found on the Institute's website and are listed in the publications section of this report in reverse chronological order. This section mentions those published in journals with an impact factor higher than 9, which account for 19% of the total. The presence of high impact factor journals such as Science (47.7), Advanced Materials (30.8), and Nature Physics (20) stands out. It is worth mentioning that 15% of the articles have been published by the American Physical Society (Physical Review Journals).

[Coherent manipulation of an Andreev spin qubit.](#) Hays, M; Fatemi, V; Bouman, D; ...Levy Yeyati, A; et al. **Science** **373**, 430-433 (Jul 2021).

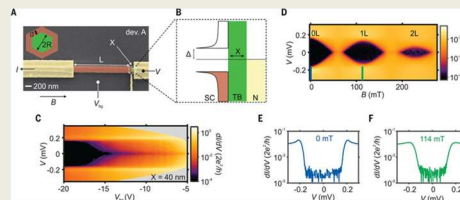
To date, the most promising solid-state approaches for developing quantum information-processing systems have been based on the circulating supercurrents of superconducting circuits and manipulating the spin properties of electrons in semiconductor quantum dots. Hays et al. combined the desirable aspects of both approaches, the scalability of the superconducting circuits and the compact footprint of the quantum dots, to design and fabricate a superconducting spin qubit (see the Perspective by Wendin and Shumeiko).



Science

[Nontopological zero-bias peaks in full-shell nanowires induced by flux-tunable Andreev states.](#) Valentini, M.; Peñaranda, F.; Hofmann A.; et al.: **Science** **373**, 82-88 (Jul 2021).

Most experimental claims of Majorana bound states, unusual quasiparticles that may become the cornerstone of topological quantum computing, rest on the observation of a persistent zero bias peak (ZBP) in tunneling spectra. In semiconductor–superconductor heterostructures, this feature may also be caused by the topologically trivial Andreev bound states.

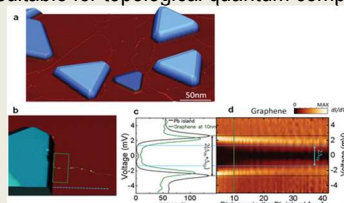


Science

[Observation of Yu–Shiba–Rusinov States in Superconducting Graphene.](#)

Cortes del Rio, E.; Luis Lado, J.; Cherkez, V.; et al.: **Adv. Mater.** **33**, 2008113 (Apr. 2021).

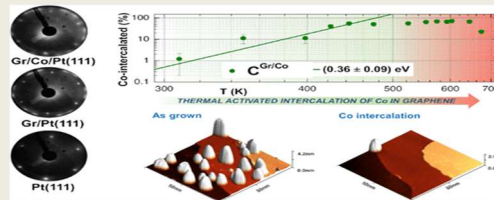
When magnetic atoms are inserted inside a superconductor, the superconducting order is locally depleted as a result of the antagonistic nature of magnetism and superconductivity. Thereby, distinctive spectral features, known as Yu–Shiba–Rusinov states, appear inside the superconducting gap. The search for Yu–Shiba–Rusinov states in different materials is intense, as they can be used as building blocks to promote Majorana modes suitable for topological quantum computing.



ADVANCED MATERIALS

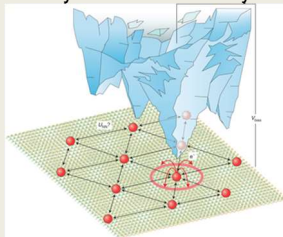
[Exfoliation of Alpha-Germanium: A Covalent Diamond-Like Structure](#), Gibaja, C.; Rodriguez-San-Miguel, D.; Paz, W.S.; et al.: **Advanced Materials** **33**, 2006826 (Mar 2021).

2D materials have opened a new field in materials science with outstanding scientific and technological impact. A largely explored route for the preparation of 2D materials is the exfoliation of layered crystals with weak forces between their layers. However, its application to covalent crystals remains elusive. Herein, a further step is taken by introducing the exfoliation of germanium, a narrow-bandgap semiconductor presenting a 3D diamond-like structure with strong covalent bonds.



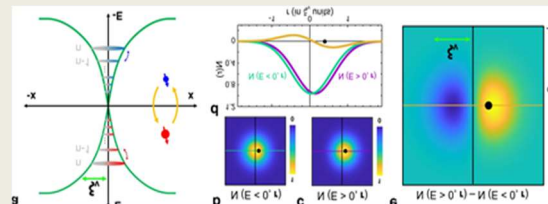
[Models and Mountains](#), Guillamón, I. **Nature Physics** **17**, 1077-1078 (Oct 2021).

In recent years, moiré superlattices formed by two-dimensional van der Waals crystals with a slightly different lattice constant or orientation have emerged as a new solid-state platform to create strongly interacting electronic states that can be described by the Hubbard model. In a moiré superlattice, the electronic bands of the different layers hybridize and can form flat bands. In these flat electron bands, the kinetic energy becomes essentially zero and arbitrarily small Coulomb interactions become the dominant energy scale.



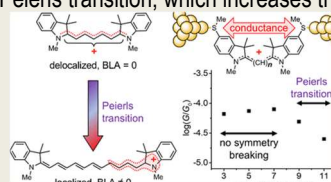
[Coherent coupling between vortex bound states and magnetic impurities in 2D layered superconductors](#), Park, S; Barrena, V; Manas-Valero, S; et al.: **Nature Communications** **12** 4668 (Aug. 2021).

Bound states in superconductors are expected to exhibit a spatially resolved electron-hole asymmetry which is the hallmark of their quantum nature. This asymmetry manifests as oscillations at the Fermi wavelength, which is usually tiny and thus washed out by thermal broadening or by scattering at defects. Here we demonstrate theoretically and confirm experimentally that, when coupled to magnetic impurities, bound states in a vortex core exhibit an emergent axial electron-hole asymmetry on a much longer scale, set by the coherence length.



[A Peierls Transition in Long Polymethine Molecular Wires: Evolution of Molecular Geometry and Single-Molecule Conductance.](#) Xu, W.; Leary, E.; Sangtarash, S.; Jirasek, M.; González, M.T. et al.: **Journal of the American Chemical Society** **143**, 20472 (Dec 2021).

Molecules capable of mediating charge transport over several nanometers with minimal decay in conductance have fundamental and technological implications. Polymethine cyanine dyes are fascinating molecular wires because up to a critical length, they have no bond-length alternation (BLA) and their electronic structure resembles a one-dimensional free-electron gas. Beyond this threshold, they undergo a symmetry-breaking Peierls transition, which increases the HOMO–LUMO gap.

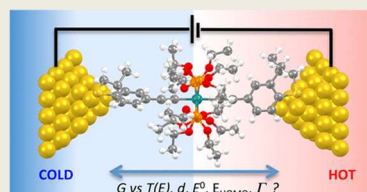


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[Molecular Structure–\(Thermo\)electric Property Relationships in Single-Molecule Junctions and Comparisons with Single- and Multiple-Parameter Models.](#) Naher M.; Milan D.C.; Al-Owaedi O.A.; Planje, I.J.; Bock, S. et al.: **Journal of the American Chemical Society** **143**, 3817 (Feb 2021).

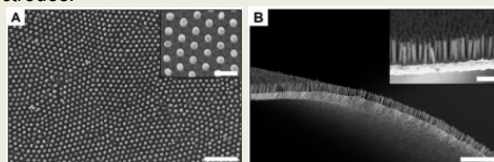
The most probable single-molecule conductance of each member of a series of 12 conjugated molecular wires, 6 of which contain either a ruthenium or platinum center centrally placed within the backbone, has been determined. The measurement of a small, positive Seebeck coefficient has established that transmission through these molecules takes place by tunneling through the tail of the HOMO resonance near the middle of the HOMO–LUMO gap in each case.

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[Nanostructured gold electrodes promote neural maturation and network connectivity.](#) Dominguez-Bajo, A.; Rosa, J. M; Gonzalez-Mayorga, A. et al.: **Biomaterials** **279**, 121186 (Dec 2021).

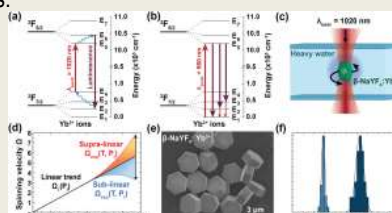
Progress in the clinical application of recording and stimulation devices for neural diseases is still limited, mainly because of suboptimal material engineering and unfavorable interactions with biological entities. Nanotechnology is providing upgraded designs of materials to better mimic the native extracellular environment and attain more intimate contacts with individual neurons, besides allowing for the miniaturization of the electrodes.



Biomaterials

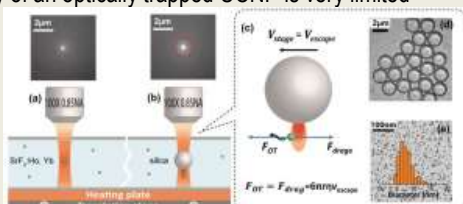
[Laser Refrigeration by an Ytterbium-Doped NaYF₄ Microspinner.](#) Ortiz-Rivero, E; Prorok, K; Martin, IR et al.: **Small** 17, 2103122 (Sep 2021).

Thermal control of liquids with high (micrometric) spatial resolution is required for advanced research such as single molecule/cell studies (where temperature is a key factor) or for the development of advanced microfluidic devices (based on the creation of thermal gradients at the microscale). Local and remote heating of liquids is easily achieved by focusing a laser beam with wavelength adjusted to absorption bands of the liquid medium or of the embedded colloidal absorbers.



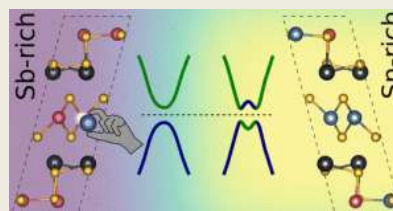
[Nanojet Trapping of a Single Sub-10 nm Upconverting Nanoparticle in the Full Liquid Water Temperature Range.](#) Lu, D.; Pedroni, M.; Labrador-Paez, L.; et al.: **Small** 17, 2006764 (Feb 2021).

Upconverting nanoparticles (UCNPs) have been used as optical probes in a great variety of scenarios ranging from cells to animal models. When optically trapped, a single UCNP can be remotely manipulated making possible, for instance, thermal scanning in the surroundings of a living cell. When conventional optics is used, the stability of an optically trapped UCNP is very limited



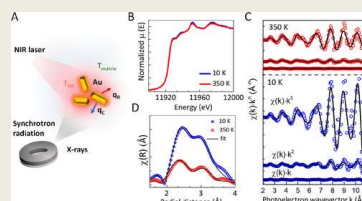
[Franckeite as an Exfoliable Naturally Occurring Topological Insulator.](#) Paz, W.S.; Menezes, M. G.; Batista, N. N.; et al.: **Nano letters** 21, 7781 (Sep 2021).

Franckeite is a natural superlattice composed of two alternating layers of different composition which has shown potential for optoelectronic applications. In part, the interest in franckeite lies in its layered nature which makes it easy to exfoliate into very thin heterostructures. Not surprisingly, its chemical composition and lattice structure are so complex that franckeite has escaped screening protocols and high-throughput searches of materials with nontrivial topological properties.



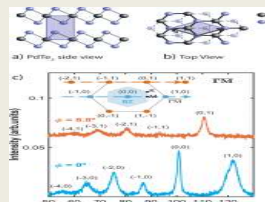
[Photoactivated Nanoscale Temperature Gradient Detection Using X-ray Absorption Spectroscopy as a Direct Nanothermometry Method.](#) Espinosa, Ana; Castro, German R; Reguera, Javier; et al.: **Nano Letters** **21**, 769 (Jan 2021)

Nanoparticle-mediated thermal treatments have demonstrated high efficacy and versatility as a local anticancer strategy beyond traditional global hyperthermia. Nanoparticles act as heating generators that can trigger therapeutic responses at both the cell and tissue level. In some cases, treatment happens in the absence of a global temperature rise, damaging the tumor cells even more selectively than other nanotherapeutic strategies.



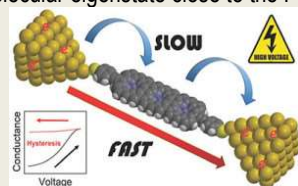
[Electron-phonon coupling in superconducting 1T-PdTe₂.](#) Anemone, G.; Casado Aguilar, P.; Garnica, M.; et al.: **NPJ 2D Materials and Applications** **5**, 25 (Feb 2021).

We have determined the electron-phonon interaction in type II Dirac semimetallic 1T-PdTe₂ by means of helium atom scattering. While 1T-PdTe₂ is isostructural with 1T-PtTe₂, only the former is superconductor. The difference can be traced to the substantially larger value of the electron-phonon coupling in 1T-PdTe₂, $\lambda = 0.58$, obtained from the Debye-Waller attenuation of the He specular peak.



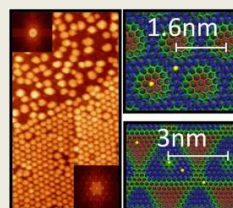
[Long-lived charged states of single porphyrin-tape junctions under ambient conditions.](#) Leary, E.; Kastlunger, G.; Limburg, B.; et al.; **Nanoscale Horizons** **6**, 49 (Jan 2021).

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.



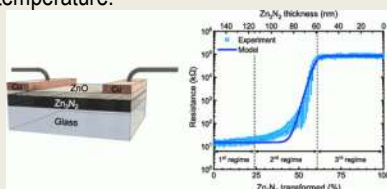
[Graphene on Rh\(111\): A template for growing ordered arrays of metal nanoparticles with different periodicities.](#) Jimenez-Sanchez, M.D.; Romero-Muniz, C.; Pou, P.; et al.: **Carbon** **173**, 1073 (Mar 2021).

Thermal control of liquids with high (micrometric) spatial resolution is required for advanced research such as single molecule/cell studies (where temperature is a key factor) or for the development of advanced microfluidic devices (based on the creation of thermal gradients at the microscale). Local and remote heating of liquids is easily achieved by focusing a laser beam with wavelength adjusted to absorption bands of the liquid medium or of the embedded colloidal absorbers.



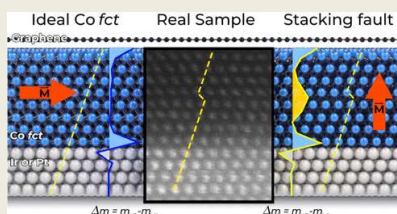
[Comprehensive Model for the Transformation of Zinc Nitride Metastable Layers.](#) Ropero-Real, A.; Gordillo, N.; Pau, J. L.; Redondo-Cubero, A.: **ACS Applied Materials & Interfaces** **13**, 56655 (Nov 21).

Upconverting nanoparticles (UCNPs) have been used as optical probes in a great variety of scenarios ranging from cells to animal models. When optically trapped, a single UCNP can be remotely manipulated making possible, for instance, thermal scanning in the surroundings of a living cell. When conventional optics is used, the stability of an optically trapped UCNP is very limited. Its reduced size leads to optical potentials comparable to thermal energy, and up to now, stable optical trapping of a UCNP has been demonstrated only close to room temperature.



[Large Perpendicular Magnetic Anisotropy in Nanometer-Thick Epitaxial Graphene/Co/Heavy Metal Heterostructures for Spin-Orbitronics Devices.](#) Blanco-Rey, M.; Perna, P.; Gudín, A.; et al.: **ACS Applied Nano Materials** **4**, 4398 (Mar 2021).

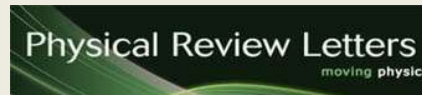
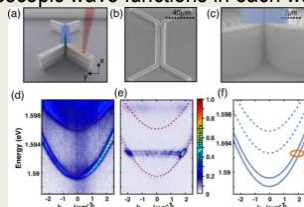
Nanometer-thick epitaxial Co films intercalated between graphene (Gr) and a heavy metal (HM) substrate are promising systems for the development of spin-orbitronic devices due to their large perpendicular magnetic anisotropy (PMA). A combination of theoretical modeling and experiments reveals the origin of the PMA and explains its behavior as a function of the Co thickness.



[Propagative Oscillations in Codirectional Polariton Waveguide Couplers.](#)

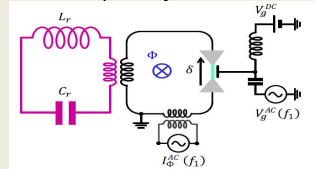
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We report on novel exciton-polariton routing devices created to study and purposely guide light-matter particles in their condensate phase. In a codirectional coupling device, two waveguides are connected by a partially etched section that facilitates tunable coupling of the adjacent channels. This evanescent coupling of the two macroscopic wave functions in each waveguide reveals itself in real space oscillations of the condensate.



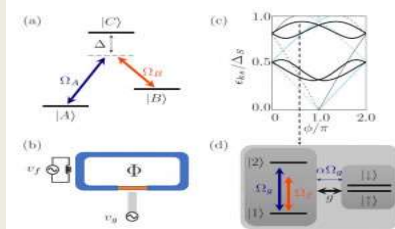
[Circuit-QED with phase-biased Josephson weak links.](#) Metzger, C.; Park, Sunghun; Tosi, L.; et al.: **Physical Review Research** **3**, 013036 (Jan 2021).

By coupling a superconducting weak link to a microwave resonator, recent experiments probed the spectrum and achieved the quantum manipulation of Andreev states in various systems. However, the quantitative understanding of the response of the resonator to changes in the occupancy of the Andreev levels, which are of fermionic nature, is missing. Here, using Bogoliubov–de Gennes formalism to describe the weak link and a general formulation of the coupling to the resonator, we calculate the shift of the resonator frequency as a function of the levels occupancy and describe how transitions are induced by phase or electric field microwave drives. We apply this formalism to analyze recent experimental results obtained using circuit-QED techniques on superconducting atomic contacts and semiconducting nanowire Josephson junctions.



[Spin coherent manipulation in Josephson weak links.](#) Cerrillo, J.; Hays, M.; Fatemi, V; et al.: **Physical Review Research** **3**, L022012 (May 2021).

Novel designs of Josephson weak links based on semiconducting nanowires combined with circuit QED techniques have enabled the resolution of their fine structure due to spin-orbit interactions, opening a path towards Andreev spin qubits. Nevertheless, direct manipulation of the spin within a given Andreev state is in general suppressed compared to interdoublet manipulation in the absence of Zeeman effects.



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Doctor Members

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60	Levy Yeyati Mizrahi, Alfredo*	THEORETICAL CONDENSED MATTER PHYSICS
61	Lifante Pedrola, Ginés*	MATERIALS PHYSICS
62	Llombart Gonzalez, Pablo	THEORETICAL CONDENSED MATTER PHYSICS
63	López Vázquez de Parga, Amadeo*	CONDENSED MATTER PHYSICS
64	Manso Silván, Miguel*	APPLIED PHYSICS
65	Marchetti, Francesca*	THEORETICAL CONDENSED MATTER PHYSICS
66	Marqués Ponce, Manuel Ignacio*	MATERIALS PHYSICS
67	Martín Fernández, María Dolores*	MATERIALS PHYSICS
68	Martín Palma, Raúl José*	APPLIED PHYSICS
69	Martín Rodríguez, Emma	APPLIED PHYSICS
70	Martínez Galera, Antonio Javier	MATERIALS PHYSICS
71	Merino Álvarez, José Manuel*	APPLIED PHYSICS
72	Merino Troncoso, Jaime*	THEORETICAL CONDENSED MATTER PHYSICS
73	Miguez Gómez, David*	CONDENSED MATTER PHYSICS
74	Miranda Soriano, Rodolfo*	CONDENSED MATTER PHYSICS
75	Molina de Pablo, Pablo*	MATERIALS PHYSICS
76	Monreal Vélez, Rosa*	THEORETICAL CONDENSED MATTER PHYSICS
77	Morant Zacaes, Carmen*	APPLIED PHYSICS
78	Nistor, Valentín	APPLIED PHYSICS
79	Ortega Mateo, José*	THEORETICAL CONDENSED MATTER PHYSICS
80	Palacios Burgos, Juan José*	CONDENSED MATTER PHYSICS
81	Pau Vizcaíno, José Luis*	APPLIED PHYSICS
82	Pérez Casero, Rafael*	APPLIED PHYSICS
83	Pérez Pérez, Rubén*	THEORETICAL CONDENSED MATTER PHYSICS
84	Pernas Martino, Pablo Luis*	APPLIED PHYSICS

	PROFESSOR - RESEARCHER	DEPARTMENT
85	Plaza Canga-Argüelles, José Luis*	MATERIALS PHYSICS
86	Polop Jordá, Celia*	CONDENSED MATTER PHYSICS
87	Prieto Recio, M ^a del Pilar*	APPLIED PHYSICS
88	Prins, Ferry	CONDENSED MATTER PHYSICS
89	Ramirez Herrero, María de la O*	MATERIALS PHYSICS
90	Ramos Ruiz, Miguel Angel*	CONDENSED MATTER PHYSICS
91	Redondo Cubero, Andrés*	APPLIED PHYSICS
92	Rodrigo Rodríguez, José Gabriel*	CONDENSED MATTER PHYSICS
93	Rodríguez Arriaga, Laura	THEORETICAL CONDENSED MATTER PHYSICS
94	Rubio Bollinger, Gabino*	CONDENSED MATTER PHYSICS
95	Sánchez López, Carlos	MATERIALS PHYSICS
96	Sánchez Muñoz, Carlos	CONDENSED MATTER PHYSICS-IFIMAC
97	Sánchez Rodrigo, Rafael	THEORETICAL CONDENSED MATTER PHYSICS
98	Sanz García, Juan Antonio	MATERIALS PHYSICS
99	Sanz Martínez, José M ^a *	APPLIED PHYSICS
100	Segovia Cabrero, Pilar*	CONDENSED MATTER PHYSICS
101	Seijo Loché, Luis Ignacio*	CHEMISTRY
102	Soler Torroja, José M ^a *	CONDENSED MATTER PHYSICS
103	Soriano de Arpe, Leonardo*	APPLIED PHYSICS
104	Suderow Rodriguez, Hermann*	CONDENSED MATTER PHYSICS
105	Tarazona Lafarga, Pedro*	THEORETICAL CONDENSED MATTER PHYSICS
106	Tejedor de Paz, Carlos	THEORETICAL CONDENSED MATTER PHYSICS
107	Van der Meulen, Herko*	MATERIALS PHYSICS
108	Velasco Caravaca, Enrique*	THEORETICAL CONDENSED MATTER PHYSICS
109	Vélez Centoral, Saül	CONDENSED MATTER PHYSICS
110	Vieira Díaz, Sebastián	CONDENSED MATTER PHYSICS
111	Viña Liste, Luis*	MATERIALS PHYSICS
112	Yndurain Muñoz, Félix	CONDENSED MATTER PHYSICS

* Permanent members of the institute council

24 % of the INC's Doctor members are women.

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PROFESSOR - RESEARCHER	DEPARTMENT
1 Calvo Membibre, Rodrigo	APPLIED PHYSICS
2 Campusano Cortés, Richard A.	THEORETICAL CONDENSED MATTER PHYSICS
3 Fernández García, Alejandro	APPLIED PHYSICS
4 Geva, Galor	THEORETICAL CONDENSED MATTER PHYSICS
5 Gómez-Argüello Gordillo, Rocío	INC
6 López Peña, Gabriel	APPLIED PHYSICS
7 Lu, Dasheng	MATERIALS PHYSICS
8 Luengo Márquez, Juan	THEORETICAL CONDENSED MATTER PHYSICS
9 Magrinyá Aguiló, Paula	THEORETICAL CONDENSED MATTER PHYSICS
10 Moratalla Martín, Manuel Eduardo	CONDENSED MATTER PHYSICS
11 Muñoz Ortiz, Tamara	MATERIALS PHYSICS
12 Naveas Ríos, Nelson Andrés	APPLIED PHYSICS
13 Ortiz Rivero, Elisa	MATERIALS PHYSICS
14 Puerto Vivar, Andrés	MATERIALS PHYSICS
15 Pulido Venegas, Ruth Noemí	APPLIED PHYSICS
16 Ramadan Shehata, Rehab	APPLIED PHYSICS
17 Ramírez Peral, M ^a Jesús	CONDENSED MATTER PHYSICS
18 Sánchez Barquilla, Mónica	THEORETICAL CONDENSED MATTER PHYSICS
19 Tiene, Antonio	THEORETICAL CONDENSED MATTER PHYSICS
20 Tíno Nieto, Berta	THEORETICAL CONDENSED MATTER PHYSICS

45% of the INC's non doctor members are women.

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