Abstract Book

2nd European Meeting on Superconductivity and Magnetism in Quantum Materials

6-9th July 2026
Braga, Portugal

Contents

Aims and Scope

Superconducting and magnetic quantum materials are rapidly emerging as essential building blocks for next-generation quantum devices, spanning an increasingly wide range of applications. Following the success of the 1st European School on Superconductivity and Magnetism in Quantum Materials held in Valencia two years ago, this meeting aims to bring together both early-career and established researchers. In particular, it seeks to provide a supportive and stimulating environment in which young scientists can present and discuss their recent achievement.

The meeting will showcase cutting-edge advances in quantum materials, with a special emphasis on the synergies arising from the interplay between superconductivity and magnetism in both bulk compounds and engineered structures. This four-day, fully in-person event will include invited talks, contributed short presentations, and a poster session. A key objective is to encourage active participation, ensuring that all attendees can present their work. The meeting will take place in a relaxed and focused setting, fostering in-depth discussions and promoting networking opportunities among participants.

Topics include, but are not limited to:

- Density functional theory of quantum materials
- Advanced theoretical modelling
- Materials design and crystal growth
- Spintronics and magnonics
- Quantum criticality in superconductors
- Unconventional, topological, and high-field superconductivity
- Scanning tunnelling microscopy (STM) and other local probe techniques

The COST Action Superqumap

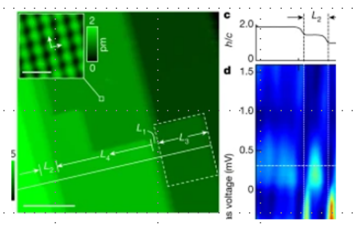
The COST Action SUPERQUMAP is organized by researchers from all European countries and includes collaborators all over the world. Superqumap started in October 2021 and will continue until October 2026. Superqumap will significantly shape research in superconductivity by a series of instruments provided by the well proven COST Action system. These includes two meetings a year, short term scientific missions and support to attend meetings organized by other entities in the same field. The management committee includes researchers from 29 countries, which share the common goal of advancing in the objectives of the Action. The approach is completely open to any researcher that can contribute to the objectives of the Action in any country.

The Action superqumap aims to harness the results obtained recently in superconductivity and build a collaborative effort to provide radically new approaches to superconducting based quantum devices. Research has three main objectives:

- To synthesize, characterize, model and understand superconducting materials and devices using a collaborative approach including techniques and capabilities available all over Europe.
- To improve our understanding of superconductors at interfaces and in combination with other systems such as magnets and insulators.
- To achieve a disruptive advance in superconducting devices for quantum technologies.

The work is organized in three work packages, which aid in shaping the meetings and networking activities in which researchers mutually benefit from complementary knowledge to advance in the objectives of the Action.

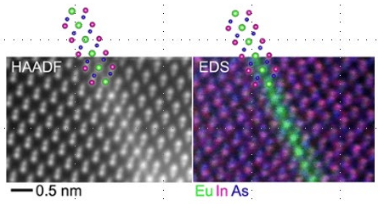
Quantum well states at the surface of a heavy-fermion superconductor, Nature (2023), https://doi.org/10.1038/s41586-023-05830-1



- Work package 1: Quantum materials
    - Obtain topological and triplet superconductivity by tuning correlations and the properties at interfaces.
    - Understand the relationship between electronic correlations, magnetism and unconventional superconducting properties.
- Work package 2: New functionalities for sensors and devices

- Control the degree of disorder in low dimensional and low carrier density superconductors.

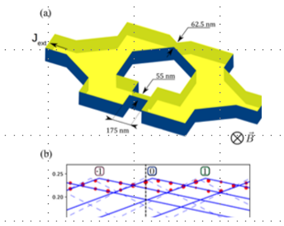
Intrinsic magnetic (EuIn)As nanowire shells with a unique crystal structure, Nano Lett (2022), 22, 8925



- Achieve a better understanding of electronic behavior between the extreme limits of infinity and zero resistance.
- Understand transport in hybrid magnetic-superconducting devices and explore the behavior of junctions made of hybrid heterostructures.

• Work package 3: Building Quantum Systems.

Metastable states and hidden phase slips in nanobridge SQUIDs, Phys Rev B (2022), 106, 134518



- Create and characterize novel two-level systems in superconducting junctions and devices suitable for quantum computation.
- Design and test methods for their coherent manipulation in quantum devices.

Organizers

Organizing Committee

Jose J. Baldoví (Co-chair), University of Valencia
Hermann Suderow (Co-chair), Universidad Autonoma de Madrid
Edwin Herrera, Universidad Autonoma de Madrid

Local Committee

Paula Obladen Aguilera
Jaime Rumeu Ozores

Scientific Advisory Committee

The COST Action Management Committee.

Grant Manager and Support

Irene González Martín

Invited Speakers

Name	Organisation
Farkhad Aliev	Universidad Autónoma de Madrid
Mohamed Khaled Arfaoui	University Grenoble Alpes
Malik Ayachi	Université Paris-Saclay
Merel Bouma	Delft University of Technology
Paul C. Canfield	Iowa State University
Carlo Cosenza	Università degli Studi di Napoli
Carolina de Almeida Marqués	University of St Andrews
Alek Dediu	ISMN-CNR
Hugo Dil	Ecole Polytechnique Fédérale de Lausanne
Mauricio Fitz de Castro-Martins Quintela	Universidad Autónoma de Madrid
Adolfo Fumega	Aalto University
Jose A. Galvís	Universidad del Rosario
Václav Janiš	Institute of Physics of the Czech Academy of Sciences
Gleb Kakazei	Universidade do Porto
Aksel Kobialka	Uppsala University
Kaveh Lahabi	Leiden University
Sara López-Paz	University of Copenhagen
Fabian Natterer	University of Zurich
María Navarro Gastiasoro	Donostia International Physics Center
Anna Palau	Insititut de Ciència de Materials de Barcelona
Nacho Pascual	CIC nanoGUNE
Bo Peng	University of Cambridge
Raquel Ribeiro	Iowa State University
Sandra Saján	Donostia International Physics Center
Thomas Samuely	Pavol Jozef Šafárik University
Andrei Shumilin	Universitat de València
Jagoda Slawinska	University of Groningen
Aleksandra Trzaskowska	Uniwersytetu Poznańskiego
Riku Tuovinen	University of Jyväskylä
Javier Villegas	Université Paris-Saclay
Beatriz Viña	Universidad Autónoma de Madrid
Ziying Wang	Aalto University
Valseka Zambra	Institute of Science and Technology Austria

Program

Time	5 July	Monday 6 July	Tuesday 7 July	Wednesday 8 July	Thursday 9 July
		Opening at 08h50 *Chair: Hermann Suderow*	*Chair:* *Maria Navarro Gastiasoro*	*Chair: Javier Villegas*	*Chair: Carolina de Almeida*
09:00		**José J. Baldoví** Engineering magnetism in two-dimensional materiales from first principles	**Nacho Pascual** Engineering YSR Landscapes with Magnetic Nanographenes on Superconductors	**Hugo Dil** Interactions in two distinct 2D electron liquids on $SrTiO_3$	**Paul C. Canfield** The ABCD's of Quantitative Solution Growth: Anchoring, Benchmarking and Challenging leading to Discovery
09:35		**Alek Dediu** New Ferromagnetic Phase Induced by Proximity Effects in Hybrid Ferromagnetic/Molecule Systems	**Carolina de Almeida** Understanding correlated electronic states through quasiparticle interference	**Aleksandra Trzaskowska** Tuning The Effective Dzyaloshinskii-Moriya Interaction in CoFeB – Based Heterostructures	**Sara López-Paz** Van der Waals magnets: from 2D to 1D

10:10		**Gleb Kakazei** Probing Spin Dynamics in Magnetic Nanoelements by Ferromagnetic Resonance	**Jose Antonio Moreno** Robust Two-dimensional Surface Superconductivity and Vortex Lattice in the Weyl Semimetal γ-PtBi2	**Jagoda Slawinska** Altermagnetism and persistent spin textures – can they interfere constructively?	**Raquel Ribeiro** Anisotropic Kondo Lattice and Magnetic Order in RCo_2Al_8 and $R_2Co_6Al_{0-2}\delta$ Single Crystals
10:45		**Coffee break**			
		Chair: Jose A. Galvis	*Chair: Gleb Kakazei*	*Chair: Raquel Ribeiro*	*Chair: Jose Baldoví*
11:15		**Farkhad Aliev** Superconducting Spintronics with Spin-Orbit Coupling and Symmetry Filtering	**Adolfo Fumega** Emergence of moiré correlated phases in twisted Mott bilayers	**Anna Palau** Magnetotransport Signatures of Spin-Orbit Coupling in High-Temperature Cuprate Superconductors	**Jose Augusto Galvis** Defect-induced multiferroicity in transition-metal dichalcogenides
11:50		**Kaveh Lahabi** Channelised Suppercurrents and Emergent Josephson Junctions in a Kagome Superconductor	**Mauricio Fitz de Castro** Magnons and excitons from Bethe-Salpeter equation in graphene-based ferromagnets	**Merel Bouma** Magnetic imaging of spin waves using solid-state spins	**Thomas Samuely** Beyond Two Dimensions: Ising Superconductivity in $NbSe_2$

12:25		**Malik Ayachi** Regular to Specular Andreev reflection in YBCO/Graphene junctions	**Javier Villegas** Giant photoconductance in infinite-layer $NdNiO_2/SrTiO_3$ heterostructures	**Carlo Cosenza** Pulse-Programmable Tunable Coupling via Tunnel Ferromagnetic Josephson Junctions	**Hermann Suderow** Direct visualization of phase slips around in-gap impurities in the magnetic semiconductor $EuCd_2As_2$
13:00		**Lunch**			
		Chair: Riku Tuovinen	*Chair: Nacho Pascual*	*Chair: Paul C. Canfield*	
15:00		**Fabian Natterer** Feenstra normalization pre and post compressive sensing recovery of WTe_2 quasiparticle interference	**Bo Peng** Fullerene quantum magnets	**Valeska Zambra** Giant Transverse Magnetic Fluctuations at the Edge of Re-Entrant Superconductivity in UTe_2	
15:35		**Sandra Sajan** Moiré-Induced Symmetry Breaking of Charge Order in Van Der Waals Heterostructures	**Andrei Shumilin** Multiscale Modeling of Magnonic Devices	**Mohamed-Khaled Arfaoui** Observation of chiral superconductivity signatures in UPt_3 with Scanning SQUID Microscopy	
16:10		**Aksel Kobialka**	**Riku Tuovinen** Electronic Transport and Noise Signatures on	**Fabian Natterer**	

		Topology and energy dependence of Majorana bound states in a photonic cavity	Superconducting Nanowires Out of Equilibrium	Feenstra normalization pre and post compressive sensing recovery of WTe2 quasiparticle interference	
16:45		**Maria Navarro Gastiasoro** Ferroaxial and Nematic Order in 1T-TiSe2	**Ziying Wang** Moiré modulated quantum spin liquid candidate 1T-TaSe2	**Beatriz Viña** Hidden Kekulé color index governs magnetic interactions in graphene	
17:20		**Coffee break**			
17:50		*Chair: Thomas Samuely*	*Chair: Fabian Natterer*	*Chair: Sara López-Paz*	
		Andriy Vovk Thermal Control of Structure, Magnetic Anisotropy, and Gilbert Damping in Epitaxial Co2FeGe Heusler Alloy Films	**Ankita Bhattacharya** Meisssner Response of Odd-frequency Superconductors	**Daniel Bobok** Topology of multi-terminal Josephson junctions with interacting two and three quantum-dot systems	
18:05		**Diego López-Alcalá** Chemical Engineering of Altermagnetism in Metal-Organic Frameworks	**Simon Kos** Low-Dimensional Critical Behavior of Correlated Electrons, Mermin-Wagner Theorem, and Local Self-Energy	**Gulnaz Rakhmanova** Mobile Impurity Across the Fulde-Ferrell-Larkin-Ovchinnikiv Phase Transition	
18:20		**Poster session**			

20h00	**Cocktail**	**Dinner**	

Abstracts- Invited

Superconducting Spintronics with Spin-Orbit Coupling and Symmetry Filtering

F.G. Aliev[1*], P. Tuero[2], C. González-Ruano[2,3], and Y. Lu[4]

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Symmetry filtering plays a crucial role in enhancing giant tunnelling magnetoresistance (TMR) by selectively allowing specific electronic states to tunnel through the barrier. Such a mechanism is key for high-performance spintronic devices like magnetic random-access memories, magnetic sensors or spin-light emitting diodes. On the other hand, spin-orbit coupling (SOC) is a central mechanism for perpendicular magnetic anisotropy in spintronics. Recently, it has become clear that SOC is crucial in mediating the interactions in heterostructures combining superconductors and ferromagnets, otherwise antagonistic materials where exotic interfacial quantum phenomena have been discovered over the last decade. Building on recent advances in studies of various V/MgO/Fe(100)-based, this talk provides a comprehensive review of superconducting spintronics driven by electron symmetry filtering and interfacial SOC [1-7]. It emphasizes the critical role of a crystalline MgO barrier in selectively transmitting specific electronic states between V(100) and Fe(100). It also highlights how interfacial SOC enables symmetry mixing, allowing for the interaction between ferromagnetic and superconducting orderings though MgO(100). This mutual interaction, mediated by interfacial SOC, facilitates the conversion of spin-singlet to spin-triplet Cooper pairs. The goal is to provide key insights into designing SOC based superconductor-ferromagnet hybrid structures for advanced superconducting spintronic functionalities.

[1] I. Martínez et al., Phys. Rev. Appl. 13, (2020) 014030.
[2] C. González-Ruano et al., Phys. Rev. B 102, (2020) 020405(R).
[3] C. González-Ruano et al., Adv. Elect. Materials, 8, (2021) 2100805.
[4] C. Gonzalez-Ruano, et al., Phys. Rev. Lett. 130, (2023) 237001.
[5] P. Tuero et al., Phys. Rev. B 110, (2024) 094504.
[6] C. Gonzalez-Ruano, et al., Nat. Commun. 16, (2025) 9524.
[7] P. Tuero et al., J. Phys. D: Appl. Phys. 59, (2026) 133003.

Observation Of Chiral Superconductivity Signatures in Upt3 with Scanning SQUID Microscopy

M.K. Arfaoui[1,3]*, P. Garcia-Campos[1], D. Aoki[2,3], J.P. Brison[3], K. Hasselbach[1]

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[2]*IMR, Tohoku University, Oarai, Ibaraki, 311-1313, Japan*
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The heavy fermion compound UPt_3 is believed to be a good candidate for spin-triplet (S=1) superconductivity. As it is shown in its phase diagram (figure 1), this unconventional superconductor (T_{c+}=0,52K) has three different superconducting phases called A, B and C. It is long believed that chiral superconductivity emerges in the B-phase (T_{c-}=0.46K) due to the Time Reversal Symmetry Breaking (TRSB) by the orbital degrees of freedom of the E2u order parameter.

In this talk, we will present our observations of the signatures of chiral superconductivity such as the fractionalization of a quantum vortex Φ_0=h/2e into two half quantum vortices Φ_0 /2, and the emergence of domain walls (figure 2) separating two superconducting chiral mono-domains (arXiv:2512.03908). The penetration depth as well as the lower critical field has been measured down to Tc/2 and we will discuss the H_{c1}(T) phase diagram as well as the temperature dependence of the penetration depth and deduce the superfluid density.

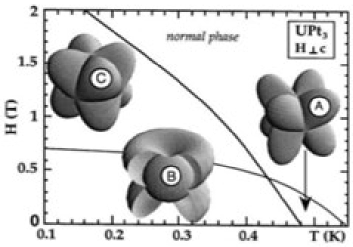

Figure 1. Superconducting phase diagram of UPt3 [1].

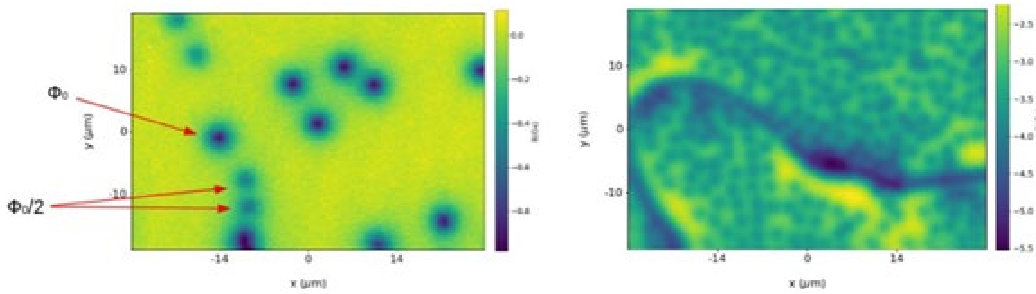

Figure 2. Scanning SQUID measurements of half quantum vortices and domain walls.

[1] J-P. Brison et al, Physica B, 280 (2000) 165-171.

Regular to Specular Andreev reflection in YBCO/Graphene junctions

Malik Ayachi[1*], Laxman Nagi-Reddy[1], Aurélien Lagarrigue[1], Christian Ulysse[2], Santiago J. Carreira[1], Andrew Mazanik[3], Sebastian Bergeret[3], Vincent Humbert[1], Javier E. Villegas[1]

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The conversion of a dissipative electron current into a non-dissipative supercurrent across a superconductor/normal-metal interface is mediated by the so-called Andreev reflection: an electron incoming from a metal can be back-reflected as a hole, yielding a net transfer of 2 elementary charges that pair up as a Cooper pair in the superconductor. If we consider a superconducting/normal graphene junction, that process is greatly influenced by graphene's characteristic electronic band structure, in particular by the presence of Dirac cones. Depending on the energy of the incoming electron, the back-reflected hole can belong to either the same or the opposite (conduction vs. valence) band. The latter case results in the inversion of the Andreev-hole reflection angle, yielding the so-called specular Andreev reflection (SAR). This translates into peculiar electrical conductance features that, up to now, have been observed only in junctions based on conventional low-Tc superconductors [1]. Despite the interest in this scenario of d-wave superconductors, whose anisotropic pairing would further enrich the conductance behavior [2], the experimental demonstration of SAR in graphene proximitized by unconventional superconductors has remained elusive. We fabricated heterostructures made of the d-wave superconductor YBa2Cu3O7 and graphene, in which graphene's Fermi level can be tuned across the Dirac point via electrostatic gating. This yields gate-controllable Andreev reflection spectra. The evolution of the differential conductance spectra as the Fermi level is swept across the Dirac point is reproduced by theoretical calculations that yield a crossover from specular to regular Andreev reflection.

Work supported by EIC Pathfinder Open under grant agreement N 101130224 "JOSEPHINE", ANR grant ANR-22-CE24-0009-01 "SEEDS" and COST action SUPERQUMAP.

[1] D. K. Efetov et al, Specular interband Andreev reflections at van der Waals interfaces between graphene and NbSe2, Nature Phys 12, 328–332 (2016).

[2] D. Perconte et al, Superconducting Proximity Effect in d-Wave Cuprate/Graphene Heterostructures, Annalen der Physik 534, 2100559 (2022).

Magnetic Imaging of Spin Waves Using Solid-state Spins

Merel Bouma[1*], Pim Vree[1], Yasmin Doedes[1], Fabian Gerritsma[1], Roland Mulder[1], Samuel Mañas-Valero[1], Michael Borst[1], Toeno van der Sar[1]

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Spin waves are collective excitations of the spins in magnetic materials. They play an important role in the thermodynamics of magnetic materials and are promising signal carriers in classical and quantum information devices. In this talk, I will introduce spin-wave imaging based on electronic sensor spins in diamond (1) – a magnetic resonance technique that enables studying spin waves underneath optically opaque materials (2). I will then describe experiments on the interaction of spin waves with normal and superconducting metals (3). For normal metals, Ohmic dissipation dominates the diamagnetic response to the stray magnetic fields of the spin waves, leading to spin-wave damping (2). In contrast, the dissipationless diamagnetism of superconductors renormalizes the spin-wave dispersion (3), resulting in spin-wave refraction that is tunable by magnetic fields and temperature. The results indicate that superconductors provide opportunities for realizing tunable, low-damping spin-wave optical devices that could be used for microwave-control in classical or quantum circuits.

[1] I. Bertelli et al., Magnetic resonance imaging of spin-wave transport and interference in a magnetic insulator. Sci. Adv. 6, eabd3556 (2020).
[2] I. Bertelli et al., Imaging Spin-Wave Damping Underneath Metals Using Electron Spins in Diamond. Adv. Quantum Technol. 4, 2100094 (2021).
[3] M. Borst et al., Observation and control of hybrid spin-wave–Meissner-current transport modes. Science. 382, 430–434 (2023).

The ABCD's of Quantitative Solution Growth: Anchoring, Benchmarking and Challenging leading to Discovery.

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Over the past decade we have been innovating the use of fritted crucibles to make solution growth more versatile and quantitative. [1] We not only discover new materials with new crystal structures, but we can also delineate and define the liquidus surface as well as identify and locate peritectic lines. In this talk I will review our recent advances and discoveries and then demonstrate how we can used these data to improve the reliability of **CAL**culated **PHA**se **D**iagrams (**CALPHAD**) by providing anchor points determined via solution growth. Iteratively improved CALPHAD can then be benchmarked or re-anchored by subsequent growths. The discovery of new compounds, especially with new crystal structures, allow experimental data to challenge the computational models with well defined compositions and structures. When (if) the models fail to accurately predict the new compound and structure, they can be examined and improved. The ultimate goal is to have phase diagram and new compound predictions that are so reliable that their predictions become actionable. When this happens there can be a 10 –fold increase in humanity's rate of discovery of new materials.

[1] Use of Frit-Disc Crucible Sets to Make Solution Growth More Quantitative and Versatile Paul C. Canfield, Tyler J. Slade https://doi.org/10.1002/zaac.202500007

Pulse-Programmable Tunable Coupling via Tunnel Ferromagnetic Josephson Junctions

Carlo Cosenza[1,*], R. Satariano[1], H. G. Ahmad[1], R. Ferraiuolo[2], G. Serpico[1], F. Calloni[1], D. Gatta[1], E. Raja[1], A. Bruno[2], D. Massarotti[3], F. Tafuri[1]

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In this work, we report the first experimental validation of the ferrotransmon concept by integrating a Superconductor–Insulator–thin-superconductor–Ferromagnet–Superconductor (SIsFS) Josephson junction into a transmon design [1,2]. In this architecture, the SFS weak link is placed in series with an SIS tunnel junction and the resulting device performance remains compatible with standard SIS-based superconducting-qubit technology [2,4]. Building on this platform, we present a tunable-coupler concept in which the inter-qubit coupling is controlled by the magnetization state of a ferromagnetic Josephson junction. In contrast to dc-SQUID-based couplers [5], which require continuous flux biasing and are therefore susceptible to low-frequency flux noise, the proposed scheme exploits the intrinsic magnetic degree of freedom of the F layer. The magnetization-dependent Josephson energy sets an effective coupling between neighboring transmons, enabling tunability at zero static flux bias. We simulate CZ-gate dynamics driven by this magnetic degree of freedom and obtain results compatible with high-fidelity operation. The scheme is pulse-programmable and compatible with superconducting control electronics, including Single Flux Quantum-Based Digital Control (SFQ) [6]. Together with the related patent application [7], this device concept represents a step toward large-scale, pulse-programmable superconducting-qubit architectures.

[1] H. G. Ahmad et al., Phys. Rev. B 105, 224508 (2022).
[2] R. Satariano et al., Appl. Phys. Lett. 127, 252601 (2025).
[3] H. G. Ahmad et al., IEEE Trans. Appl. Supercond. 35, 1 (2025).
[4] A. Vettoliere et al., Appl. Phys. Lett. 120, 262601 (2022).
[5] Yan et al. PRA, 10.054062 (2018).
[6] Jordan et al. Nature Electronics 10.1038/s41928-026-01576-6 (2026).
[7] European Patent Application No. 24425069.2 (submitted).

Understanding Correlated Electronic States Through Quasiparticle Interference

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Whether a material is metallic, insulating, or superconducting is intrinsically related to the dispersion of its electronic states across the Fermi level and the shape of the Fermi surface. The electronic structure is determined by an intricate relationship between the symmetry of the atomic lattice, Coulomb repulsion, electron-phonon coupling, exchange splitting and spin-orbit coupling, being responsible for the rich phase diagrams found in strongly correlated electron materials, with examples including the cuprate, iron-based and heavy fermion superconductors. To enable a controlled manipulation of the electronic states of these materials to induce desired electronic properties, it is thus necessary to know how the different underlying microscopic mechanisms affect the electronic structure and how to tune them.

The electronic dispersion in momentum space can be measured indirectly in scanning tunneling microscopy (STM) via quasiparticle interference (QPI) by detecting the quantum interference patterns around defects with extremely high energy resolution. In a single band system, the relationship between the momentum space and the characteristic wave vectors seen in the quantum interference patterns is trivial, however, it can become quite complicated for multiband systems, as well as when spin-orbit coupling and electronic correlations play a significant role. In this talk, I will discuss the case of strontium ruthenate as a model system [1-4] that enabled development of a framework [5] to model QPI. Using continuum local density of states calculations in comparison with experiment, this framework allows to illustrate the role of microscopic mechanisms in the electronic structure of correlated electron materials, such as the role of wavefunction overlap, spin-orbit coupling and ultimately, self-energy effects.

[1] C. A. Marques, L. C. Rhodes, R. Fittipaldi, V. Granata, C. M. Yim, R. Buzio, A. Gerbi, A. Vecchione, A. W. Rost, and P. Wahl, Adv. Mater. 33, 2100593 (2021).
[2] A. Kreisel, C. A. Marques, L. C. Rhodes, X. Kong, T. Berlijn, R. Fittipaldi, V. Granata, A. Vecchione, P. Wahl and P.J. Hirschfeld, npj Quantum Materials 6, 100 (2021).
[3] A. Chandrasekaran, L. C. Rhodes, E. A. Morales, C. A. Marques, P. D. C. King, P. Wahl and J.J. Betouras, Nat. Commun. 15, 9521 (2024).
[4] J. B. Profe, L. C. Rhodes, M. Dürrnagel, R. Bisset, C. A. Marques, S. Chi, T. Schwemmer, R. Thomale, D. M. Kennes, C. Hooley and P. Wahl, Phys. Rev. Res. 6, 043057 (2024).
[5] P. Wahl, L. C. Rhodes and C. A. Marques, SciPost Physics Codebases 61 (2025).

New Ferromagnetic Phase Induced by Proximity Effects in Hybrid Ferromagnetic/Molecule Systems

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The interplay between Hund's coupling, exchange interaction and magnetic anisotropy is responsible for a multitude of magnetic phases, ranging from conventional ferromagnetism to exotic spin textures.

Yet, engineering and finetuning a magnetic state remains a major challenge in modern magnetism. I will show that the chemisorption of organic molecules over 3d ferromagnetic thin films offers a tool to transform the films from ferromagnetic to a glassy-type state. This emerges when the correlation length of the random anisotropy field, induced by the π-d molecule/metal hybridization, is comparable to the characteristic exchange length.

This state is characterized by the collapse of the conventional domain structure and the emergence of blurred pseudo-domains, intertwined with diffuse and irregular domain walls [1]. Magnetization reversal also gives rise to topological vortex-like structures, as predicted and subsequently confirmed by magnetic-force microscopy. At the macroscopic level, this novel glassy ferromagnetic state is characterized by an extraordinary magnetic hardening and a breakdown of Rayleigh law in low-field (minor loops) magnetization reversal.
Intriguingly, these properties—induced through interfacial engineering—extend several nanometers into the bulk of ferromagnetic films, thereby enabling a versatile approach for tailoring key magnetic parameters on demand across a range of magnetic and spintronic applications. Moreover, the resulting magnetic hardening can be tuned, or even reversibly switched on and off, by external stimuli such as light and electric fields. This behavior, demonstrated in ultrafast magnetization dynamics experiments [2], opens promising pathways toward novel device paradigms [3].

[1] Benini et al. Nature Communications 16 (1), 5807 (2025).
[2] Benini et al. Nature Communications 16 (1), 7297 (2025).
[3] Cinchetti, Dediu, Hueso. Nature Materials 16 (5), 507 (2017).

Interactions in Two Distinct 2D Electron Liquids on Srtio3

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A truly bulk-terminated SrTiO3(001) surface can be prepared by cleaving in situ a strained single crystal. This way regions with pure TiO2 or SrO termination can be obtained as characterised with noncontact atomic force microscopy (ncAFM). These regions are large enough to be studied by angle-resolved photoemission spectroscopy (ARPES) with a spot size of about 10 micron, whereby we used scanning electron microscopy (SEM) on the counter piece to correlate ARPES and AFM data. In contrast to claims of a hole-like state on SrO terminated SrTiO3, both terminations are found to host a well-defined 2D electron liquid (2DEL) with identical band filling, but with significantly different electronic structure and time needed to develop the state. On the SrO terminated surface it takes relatively long for the 2DEL to develop and it is found to be degenerate, whereas on the TiO2 termination the 2DEL develops almost instantaneously and the degeneracy is lifted. We explain these differences with the need to form oxygen vacancies on the SrO termination, whereas on the TiO2 termination a structural distortion leads to the trapping of excited electrons.

The unprecedented high surface quality allows us to characterise the interactions in the system. We can extract the real and imaginary part of the self energy and using the maximum entropy method perform the integral inversion to obtain the Eliashberg function. The phonon modes correspond well to those obtained from calculations and electron-phonon coupling is found to play an important role in this system. Furthermore, the 2DEL is found to exist up to room temperature and this allows us to follow the temperature dependency of these interactions. In general, the obtained results enable us to elucidate the underlying mechanisms on this long studied system [1].

[1] Igor Sokolović, Eduardo B. Guedes, Thomas P. van Waas, Fei Guo, Samuel Poncé, Craig Polley, Michael Schmid, Ulrike Diebold, Milan Radović, Martin Setvín, and J. Hugo Dil, Nature Communications 16, 4594 (2025).

Magnons and Excitons From Bethe-salpeter Equation in Graphene-based Ferromagnets

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With the recent isolation of two-dimensional semiconducting magnetic materials, the interest in the theoretical study of spin-flip excitations (magnons) along with the spin-conserving excitations (excitons) has become particularly relevant. Describing both types of quasiparticles within the same theoretical framework has proven to be challenging, in particular, because the well-established Bethe-Salpeter equation (BSE) formalism for the calculation of excitons presents difficulties when applied to magnons. Here, we present a comprehensive view of the origin of these difficulties, which allows us to propose a coherent path to compute excitons and magnons on the same footing, while respecting the Goldstone mode for magnons. As an example, we apply it to ferromagnetic hydrogenated graphene, using a simple, but still realistic, extended Hubbard model.

Emergence Of Moiré Correlated Phases in Twisted Mott Bilayers

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Twist engineering has emerged as a powerful route to create electronic phases that do not exist in the constituent materials. While much attention has focused on moiré semiconductors, the interplay between moiré physics and strong electronic correlations remains a largely unexplored frontier. In this talk, I will discuss how twisting layered Mott materials provides a versatile platform to engineer novel correlated quantum phases with spatially modulated electronic properties.

I will focus on recent theoretical advances in twisted transition-metal dichalcogenides hosting charge-density-wave Mott states [1]. In particular, I will show that twisted bilayers of 1T-TaS_2 realize a new type of correlated moiré state arising from the competition between many-body Mott insulating behavior and stacking-dependent single-particle gaps. This interplay generates moiré Mott mosaics, in which regions hosting localized magnetic moments coexist with non-magnetic insulating domains within the same moiré supercell. Furthermore, the correlated landscape can be continuously tuned by an interlayer electric field, enabling controllable charge transfer and the selective suppression of local correlations.

Building on these theoretical concepts, I will discuss some recent experimental results, where we observe how electronic interactions and stacking engineering in Mott bilayers can give rise to an emergent ferroelectric order [2]. We will reveal that different stacking configurations on bilayer 1T-$TaSe_2$ realize distinct correlated phases, ranging from hybridization-driven band insulators to interaction-driven ferroelectric charge-density-wave states. In the latter case, spontaneous charge transfer between layers generates an out-of-plane electric polarization without requiring structural inversion-symmetry breaking, providing a striking example of electronically driven ferroelectricity.

These results establish twisted and stacked Mott bilayers as a fertile platform for designing emergent quantum matter, where moiré engineering, strong correlations, magnetism, and ferroelectricity become intimately intertwined.

[1] Ana Vera Montoto, Jose L. Lado and Adolfo O. Fumega, Arxiv, 2604.02001 (2026).

[2] Ziying Wang, Ana Vera Montoto et al., In preparation (to appear in summer 2026).

Defect-induced Multiferroicity in Transition-Metal Dichalcogenides

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Transition-metal dichalcogenides constitute a versatile platform for engineering ferroic phenomena at the atomic scale due to their tunable crystal and electronic structure. In this work, we investigate the structural, magnetic, and ferroelectric properties of bulk solid-solution $W(Se_{1-x}Te_x)_{2(1-\delta)}$ single crystals[1]. The influence of tellurium substitution (x) and chalcogen deficiency (δ) on room-temperature ferroic behavior is systematically explored. Structural characterization by X-ray diffraction and Raman spectroscopy reveals lattice expansion and symmetry lowering with increasing Te content, leading to a 2H-to-1Td structural transition. Piezoresponse force microscopy demonstrates piezoelectric behavior near stoichiometric compositions and switchable ferroelectricity in samples with high chalcogen-vacancy concentrations. Magnetometry measurements show a concurrent evolution from paramagnetic to ferromagnetic behavior as δ increases. While Te substitution primarily controls crystal symmetry, chalcogen vacancies drive the emergence of both ferroelectric and ferromagnetic responses. As a result, multiferroic states arise in highly deficient compositions through the coexistence of ferroelectric and ferromagnetic ordering. These observations are summarized in a configurational phase diagram that highlights the cooperative role of chemical substitution and defect engineering in tailoring ferroic properties. Our results demonstrate that stoichiometry and vacancy control provide an effective route for designing multifunctional ferroic states in layered transition-metal dichalcogenides.

[1] H. Rojas-Páez and G. Villabón-Linares and J. Pazos and E. Ramos and R. Moreno and O. Herrera-Sandoval and J. A. Galvis and P. Giraldo-Gallo, arXiv, https://arxiv.org/abs/2603.08515 (2016).

A Consistent Theory of Superconductivity Beyond the Mean-field BCS Approximation

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The theoretical description of the superconducting phase is predominantly based on the mean-field theory of Bardeen-Cooper-Schrieffer (BCS). It is presently the only fully consistent theory of the superconducting order parameter. Attempts to go beyond the BCS theory by including dynamic fluctuations failed to match the critical point of the instability of the high-temperature metallic phase with the emergence of the superconducting order parameter [1]. A similar discrepancy also holds for the magnetic order beyond the static Hartree-Fock approximation [2]. Based on the recently proposed solution to the mismatch between the low-and high-temperature critical points in itinerant antiferromagnets [2], we propose the correct way to extend the dynamic approximations with the frequency-dependent self-energy from the metallic to the superconducting phase. We analyze all formally acceptable contributions from Feynman diagrams that contain anomalous Green functions [3]. We identify the reason for the mismatch between the instability of the metallic phase and the vanishing of the superconducting order parameter as the inclusion of diagrams that do not conserve the number of excited states during scattering processes. Imposing conservation of the number of excited states yields a class of diagrams that match the vanishing of the superconducting order to the critical point of the instability of the metallic phase. We apply the general approach based on the self-consistent T-matrix approximation to demonstrate that the proposed suppression of the non-conserving anomalous diagrams results in the vanishing of the superconducting order parameter at the critical point of the instability of the high-temperature metallic phase, yielding a continuous transition. We further disclose that the superconducting phase with dynamic fluctuations is generically characterized by a two-gap structure, with a larger dynamic gap that contains BCS in-gap states. We thereby proved that the lowest-lying excitations of the superconductor are always of the BCS type.

[1] K, Levin, Q. Chen, C.-C. Chien, and Y. He, Ann. Phys. (NY) 325, (2010) 233-264.

[2] V. Janiš, M. Khanore, and A. Klíč, Phys. Scr. 101 (2026) 155904.

[3] V. Janiš and V. Pokorný, Sci. Lett. J. 3 (2014) 1-9.

Probing Spin Dynamics in Magnetic Nanoelements by Ferromagnetic Resonance

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Patterned magnetic nanostructures are advanced materials whose unique nanoscale magnetic properties arise from tailored geometry and composition. As nanotechnology rapidly advances, these systems are becoming a key focus for both industry and academia. This talk presents an overview of standing spin waves (collective spin precessions) in magnetic elements studied by ferromagnetic resonance (FMR) [1]. It covers earlier cavity-based FMR investigations of arrays of magnetic nanodisks and nanorings, as well as more recent broadband FMR studies of individual nanodisks and three-dimensional "nanovolcanoes" using a coplanar waveguide.

Transitioning into the third dimension enables spintronic nanodevices with substantially enhanced functionality compared to conventional planar structures. Recently, well-known two-dimensional magnetic vortex configurations—which exhibit an efficient dynamical response to external stimuli without a bias magnetic field—were extended into 3D [2]. This leads to a marked increase in vortex frequencies, up to 5 GHz, compared with the typical sub-GHz range in planar vortex oscillators. A systematic study reveals a complex spectrum of vortex excitation modes, accounting for the reduction of the lowest gyrotropic mode frequency, the inversion of vortex mode intensities, and the nontrivial spatial distribution of the vortex dynamical magnetization.

Overall, the talk traces the development of FMR studies along two main directions: (i) downscaling from ensembles to individual magnetic nanoelements and (ii) extending planar nanomagnets into three dimensions.

[1] O. Dobrovolskiy and G. Kakazei, Spin Waves in Magnetic Nanodisks, Nanorings, and 3D Nanovolcanoes. In: Fomin, V.M. (eds) Physics of Quantum Rings. NanoScience and Technology, Springer (2025) 277–314.

[2] A.V. Bondarenko, S.A. Bunyaev, A.K. Shukla, A. Apolinario, N. Singh, D. Navas, K.Y. Guslienko, A.O. Adeyeye, and G.N. Kakazei, Dominant higher-order vortex gyromodes in circular magnetic nanodots, Nanoscale Horizons, 9 (2024) 1498–1505.

Topology And Energy Dependence of Majorana Bound States in a Photonic Cavity

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Light-matter interaction plays a crucial role in modifying the properties of quantum materials. We investigate the effect of cavity induced photon fields on a topological superconductor hosting Majorana bound states (MBS). We model the system using a Peierls substitution of the photonic operator in the kinetic and spin-orbit terms, and utilize an exact diagonalization of Hamiltonian for a finite number of photons to probe the coupled system.

We find that the MBS persist even in the presence of a cavity field and notably appear at finite and tunable energy, in contrast to a usual 1D topological superconductor. The MBS energy is shifted by two processes: the cavity photon energy adds a constant energy shift, while the light-matter interaction induces additional parameter dependencies, such that the MBS experience a pseudo-dispersion as a function of both light-matter interaction and magnetic field.

Additionally, we find that the MBS energy oscillations are suppressed with increasing light-matter interaction and that disorder stability is not impacted by the light-matter interaction. Combined, these offer additional tunability and stability of the MBS.

As a second result, we establish a modified spectral localizer formalism as an essential tool for topological characterization of quantum matter in a cavity. The spectral localizer allows characterization at arbitrary energies, which is needed for probing different photon sectors. However, hybridization between different photon sectors in the low-frequency regime limits a straightforward application of a standard spectral localizer. We fully resolve this issue by judiciously applying an energy shift to the spectral localizer.

Our work thus introduces a new avenue for controlling MBS via light–matter coupling and provides a framework for exploring cavity-modified topologies.

Channelised Supercurrents and Emergent Josephson Junctions in a Kagome Superconductor

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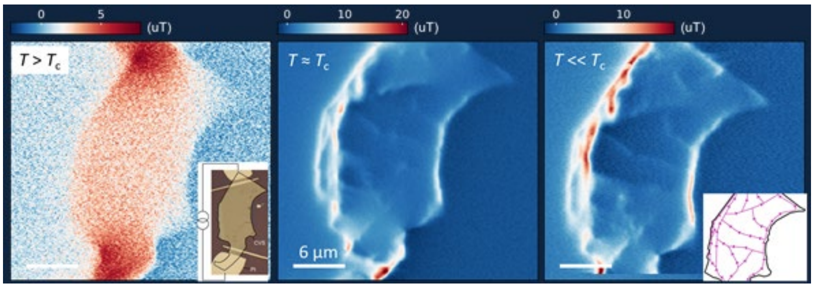
Recent studies on the AV_3Sb_5 (A= Cs, K, Rb) family of kagome superconductors have revealed a range of unusual transport phenomena, including zero-field diode effects, emergent Josephson junctions [1], and signatures of higher-order Cooper pairing. Although these observations are often linked to the interplay between superconductivity and the competing charge-density-wave (CDW) order in these materials, their microscopic origin remains unknown. Contributing to this challenge is the lack of local information on superconducting transport. Here, we employ a recently developed scanning SQUID-on-tip microscope [2] to directly image the flow of supercurrents in flakes of $CsV_3Sb_{5-x}Sn_x$. [3]

Supercurrents are expected to follow a relatively simple spatial pattern in both conventional and unconventional superconductors (e.g., our control experiments on $NbSe_2$ flakes). Here, we find a striking exception in a kagome superconductor, where supercurrents can only flow in networks of highly confined channels (a small fraction of the expected supercurrent path). These channels emerge abruptly at the superconducting transition and remain remarkably stable with respect to temperature, current, and thermal cycling. Interestingly, this effect is substantially weaker in the undoped CsV_3Sb_5, suggesting a close link to the evolution of CDWs, disorder and electronic correlations (all strongly influenced by doping). Lastly, we find a direct correspondence between the spatial distribution of the supercurrent channels and the magnetic interference pattern of the flakes.

Our results reveal an unexpected form of superconducting transport in kagome materials and establish a firm connection between channelized supercurrents and the anomalous magnetic interference patterns reported in AV_3Sb_5 devices.



[1] T. J. Blom, M. Rog, ..., K. Lahabi, Nano Lett. (2026) https://doi.org/10.1021/acs.nanolett.5c05587.
[2] M. Rog, ..., K. Lahabi, Nano Lett. 26 (2026) 1608–1615 https://doi.org/10.1021/acs.nanolett.5c04571
[3] M. Rog, T. J. Blom, ..., K. Lahabi (2026) https://arxiv.org/abs/2606.20157

Van der Waals Magnets: from 2D to 1D

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The handling of two dimensional (2D) materials through the exfoliation of bulk van der Waals materials first led to a dramatic improvement of semiconductor technologies, and a magnetic twist to this materials is currently boosting the development of next-generation spin-based quantum technologies based on magnetic 2D monolayers.[1-2] Here, increasing the chemical complexity of van der Waals magnets through the combination of different anions unlocked further functionalities in anisotropic quasi-one dimensional (1D) magnets.[3-4]
Now, recent advances in chemical exfoliation and encapsulation may allow the isolation of one-dimensional magnets at the nanoscale from ionic bulk materials.[5-6] In this talk, challenges and opportunities for the manipulation of this materials class through chemical doping, microstructural modifications and external pressure will be discussed.

[1] Park, J. *et al.*, *Rev. Mod. Phys.*, **98** (2026) 025003.
[2] Wang, Q. H. *et al., ACS Nano* **16**, 5 (2022) 6960.
[3] S. A. López-Paz, *et al*., *Nat. Commun.*, **13** (2022) 4745.
[4] S. A. López-Paz, *et al*., *J. Mater. Chem. A*, **14** (2026) 1681.

Feenstra Normalization Pre and Post Compressive Sensing Recovery of Wte$_2$ Quasiparticle Interference

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The combination of compressive sensing and parallel spectroscopy can fundamentally speed up quasiparticle interference (QPI) measurements with the scanning tunneling microscope[1]. We first review the basics of parallel spectroscopy to measure the IV characteristics of a tunneling junction using a Chebychev formalism. We then compare the effect of different normalization procedures on the compressive sensing recovery of the quasiparticle interference pattern of the model system WTe_2 that has been shown to exhibit a rich set of scattering vectors. Line profiles along q_x and q_y show sharper q-vectors for sparsely sampled dI/dV first normalized by I/V, also referred to as Feenstra normalization, and then compressive sensing recovered QPI. In contrast, the separately compressive sensing recovered dI/dV and I with subsequent normalization leads to worse line-shapes, despite visually better appearance in local density of states mapping. We discuss potential extensions and tweaks to further enhance QPI signatures to prepare for of large field of view QPI characterization 2D quantum materials, including the dispersion of in-gap states in superconductors.

[1] B. Zengin et al., Physical Review Research 3, L042025 (2021).
[2] R. Sánchez-Barquilla et al., Phys. Rev. B 112, 165401 (2025).

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Ferroaxial and Nematic Order in 1T-$TiSe_2$

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Charge density waves (CDWs) with multi-component order parameters can break unexpected symmetries through the interplay of nearly degenerate instabilities. In the widely investigated material 1T-$TiSe_2$, whether the observed CDW spontaneously breaks mirror and inversion symmetries to form a chiral state has remained controversial, with previous experiments reporting conflicting results. Here, we resolve this controversy by identifying the bulk broken symmetry as ferroaxial, corresponding to the breaking of vertical mirrors while preserving inversion symmetry. Simultaneous symmetry-resolved elastoresistivity and elastocaloric measurements uncover a hierarchy of symmetry-breaking transitions: the primary CDW is followed by a ferroaxial instability, which in turn acts as the parent state for a second nematic instability [1]

None of the possible configurations of the leading CDW mode, which transforms as the L_1^- irrep, can produce ferroaxial order, and symmetry requires a secondary mode belonging to a different irrep to break the vertical mirrors. We develop a Landau theory for the leading CDW mode coupled to relevant secondary mode candidates, analyze the resulting phase diagrams in the presence of strain, and consider the implications for the candidates.

[1] S. P. Edwards et al, arXiv:2603.14614 (2026).

Magnetotransport Signatures of Spin-Orbit Coupling in High- Temperature Cuprate Superconductors

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Spin transport in superconductors offers a compelling platform to merge the dissipationless nature of superconductivity with the functional promise of spin-based electronics. A significant challenge in achieving spin polarisation in conventional superconductors stems from the singlet state of Cooper pairs, which exhibit no net spin. The generation of spin-polarised carriers, quasiparticles, or triplet pairs in superconductors has predominantly been realised in hybrid superconductor/ferromagnet systems through proximity-induced spin polarisation. Historically, cuprate superconductors have been characterised by strong electronic correlations but negligible spin-orbit coupling. In this study, we observe a large in-plane angle-dependent magnetoresistance and a pronounced planar Hall effect arising near the superconducting phase transition in the prototypical high-temperature cuprate superconductor $YBa_2Cu_3O_{7-x}$ without using a proximity ferromagnet. These effects - unusual in centrosymmetric cuprates - may arise from spin-polarised quasiparticle transport potentially mediated by strong spin-orbit coupling. By systematically tuning magnetic field strength, orientation, temperature, and doping, we identify transport signatures that are consistent with spin-orbit-driven phenomena. Our findings suggest the presence of a previously underappreciated spin-orbit landscape in cuprates, which may provide the basis for exploring spintronic functionalities in high-temperature superconductors.

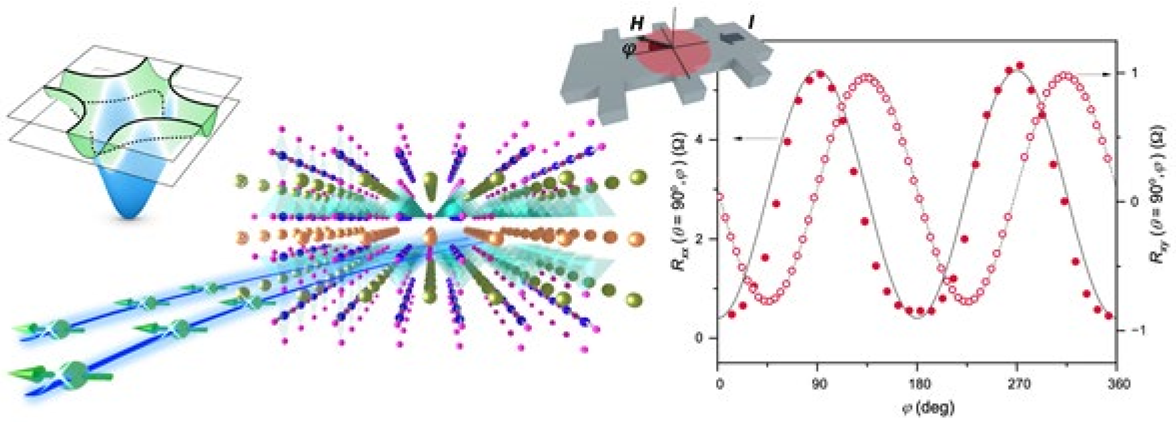

Fig. 1: *Anomalous angle-dependent magnetoresistance and planar Hall effect in High-Temperature YBCO films*

[1] Barrera et al. Advanced Science (In press).

Engineering YSR Landscapes with Magnetic Nanographenes on Superconductors

K. Vaxevani[1], Jon Ortuzar [1], Stefani Trivini [1], Fran Romero [1], Trisha Sai, Frederik Bauer [1], Jose Esteban Andino [1], Cristina Mier [1], Leonard Edens [1], Nacho Pascual[1,*]

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On-surface synthesis (OSS) achieves atomically precise nanostructures with engineered electronic and magnetic properties. It has been shown that these molecular platforms can recreate paradigmatic correlated systems and symmetry-protected topological order. Their integration on a superconducting condensate is a key step toward hybrid quantum devices that exploit both topological spin correlations and superconducting pairing. However, integrating carbon nanostructures with superconductors has remained challenging because OSS requires the catalytic properties of bulk gold, incompatible with conventional superconducting surfaces. Here, we demonstrate that proximitized superconducting gold films grown on Nb(110) overcome this limitation: the thin Au film ($\lesssim$ coherence length) retains the electronic and catalytic properties of bulk Au(111) while hosting proximity-induced superconductivity. We present recent results from several nanographene platforms synthesized on this superconducting gold surface, revealing YSR bound states and correlated excitations of the carbon platforms. We have studied spin-1 triangulene Haldane chains, first synthesized by Mishra et al. [1] on Au(111), which exhibit spin-1/2 edge states protected by a topological spin-excitation gap in the bulk. Our measurements on proximitized Au/Nb reveal both YSR resonances and edge spin excitations with striking parity-dependent behavior: odd-length chains display YSR states inside the gap, while even-length chains show only extragap singlet–triplet excitations. We have also studied chiral graphene nanoribbons, which host symmetry-protected topological boundary states. These states were depopulated on Au(111) due to the large work function and associated electron transfer. On Au/Nb, the reduced work function maintains ribbon neutrality, and we resolve YSR states that couple the topological end states to the superconducting condensate, directly confirming their $Z_2 = 1$ topological class. We also present results on aza-nanographenes with tunable open-shell character on proximitized gold. Multiple YSR peaks reveal a tiny Jahn–Teller-induced orbital splitting. Together, these results establish proximitized Au/Nb(110) as a versatile platform for coupling correlated and topological states in carbon nanostructures to superconducting pairing, opening pathways toward topologically protected superconductor–nanographene hybrids.

[1] S. Mishra, Nature 598, 287 (2021).
[2] JC. L, Nature Commun. 12, 5538 (2021).
[3] F. Romero et al. Arxiv 2512.10869 (2025).

Fullerene Quantum Magnets

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Molecules provide more tuneable building blocks than atoms [1,2] and can self-assemble into larger structures [3,4] with richer structural behaviours [5] for quantum devices. Using pure-carbon fullerene molecules that were believed to be non-magnetic [6], we show that magnetism in this material family can be induced purely by symmetry [7]. We can then use this pure-carbon magnetic material to design various quantum platforms, based on experimentally synthesised monolayers [8,9], to realise exotic quantum phenomena such as ferromagnetic Chern insulators [10], antiferromagnetic spin chain [11], altermagnetism and quantum spin liquid [12], as well as magnetoelectrics where spins can be controlled by electric fields. If time allows, I will also discuss my ongoing research that combines both atomic and molecular building blocks. With this approach, we can unlock even more exciting applications such as quantum timekeeping and quantum simulation.

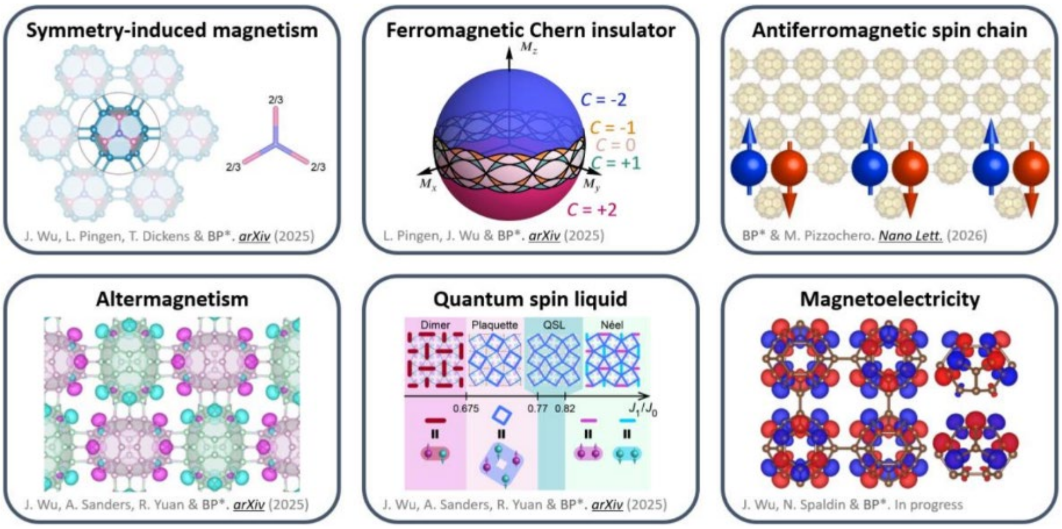

Figure. A zoo of magnetic fullerene.

[1] B. Peng*, J. Am. Chem. Soc., 144 (2022) 19921.
[2] J. Wu and B. Peng*, J. Am. Chem. Soc., 147 (2025) 1749.
[3] B. Peng*, Nano Lett., 23 (2023) 652.
[4] B. Peng* and M. Pizzochero*, ACS Nano 19 (2025) 29637.
[5] A. Shaikh, J. Wu and B. Peng*, Phys. Rev. Lett. 135 (2025) 126103.
[6] T. L. Makarova, et al, Nature 413 (2021) 716 [Retracted].
[7] J. Wu, L. W. Pingen, T. K. Dickens and B. Peng*, arXiv:2508.18125.
[8] L. Hou, et al, Nature 606 (2022) 507.
[9] E. Meirzadeh, et al, Nature 613 (2023) 71.
[10] L. W. Pingen, J. Wu and B. Peng*, arXiv:2508.19849.
[11] B. Peng* and M. Pizzochero*, Nano Lett., 26 (2026) 6034.
[12] J. Wu, A. Sanders, R. Yuan and B. Peng*, arXiv:2508.21056.

Anisotropic Kondo Lattice and Magnetic Order in RCo_2Al_8 and $R_2Co_6Al_{0-2}\delta$ Single Crystals

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The $CaCo_2Al_8$-type orthorhombic structure, with rare-earth (R) cations organized in chains along the c-axis, provides a compelling platform for investigating anisotropic Kondo lattice behavior and competing magnetic interactions. I present results from two families of R-Co-Al single crystals grown from Al-rich solutions. In the RCo_2Al_8 series (R = La, Ce, Pr, Nd, Sm), $LaCo_2Al_8$ serves as a Pauli paramagnetic reference with strong intrinsic electronic anisotropy. $CeCo_2Al_8$ is an anisotropic Kondo lattice with two distinct coherence due to Fermi surface anisotropy. Pr- and Nd-based compounds display easy-axis antiferromagnetic order with metamagnetic transitions, and $SmCo_2Al_8$ orders antiferromagnetically below ~22 K. Partial Co by Ni substitution tunes this anisotropy non-trivially. The non-monotonic evolution of Kondo temperatures with Ni content indicates that doping modifies the crystalline electric field, beyond simple band-filling. Extending the series to heavy rare earths led to the discovery of $R_2Co_6Al_{0-2}\delta$ (R = Gd–Tm, Y) in an orthorhombic Imma structure. All magnetic members order antiferromagnetically (T_N = 1.8–11.8 K), with Gd and Tb showing two consecutive transitions. Deviations from de Gennes scaling and an anisotropy crossover across the series highlight the interplay between RKKY exchange and crystalline electric field interactions in this orthorhombic system.

Moiré-Induced Symmetry Breaking of Charge Order in Van Der Waals Heterostructures

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Layered materials that combine different crystal symmetries are uncommon in nature and provide a unique opportunity to study how competing structural motifs influence collective electronic behavior. Misfit layered chalcogenides, composed of rocksalt monochalcogenide and transition-metal dichalcogenide layers, offer a natural platform in which square and hexagonal lattices coexist. Using low-temperature scanning tunneling microscopy and spectroscopy, we investigate the misfit compounds $(MS)_{1+\delta}TaS_2$ (M = Pb, Sn) and examine how the misfit interface modifies the electronic ground state of embedded 1H-TaS_2 monolayers. We find that the charge-density wave (CDW) becomes incommensurate and breaks into nanometer-scale domains. Moreover, the CDW responds strongly and anisotropically to the uniaxial moiré potential generated by the misfit layer, leading to direction-dependent coherence lengths and ordering wavevectors. These observations reveal a pronounced coupling between the intrinsic CDW instability and the symmetry-breaking moiré field. Multiscale modeling informed by first-principles calculations shows that this behavior arises from the combined effects of interlayer charge transfer and an anisotropic energy landscape imposed by the misfit interface. In contrast, superconductivity remains largely unaffected, exhibiting a uniform full energy gap consistent with conventional s-wave pairing. Our results demonstrate how heterosymmetry stacking can selectively reshape competing electronic orders and establish misfit layered materials as a promising platform for engineering correlated quantum states.

[1] S. Sajan, L. Pätzold, T. Agarwal, C. Pfister, H. Guo, S. Duan, P. V. Sruthibhai, M. Rossi, M. N. Gastiasoro, S. Barja, R. P. Singh, T. Wehling and M. M. Ugeda, arXiv, 2603.05759 (2026).

Beyond Two Dimensions: Ising Superconductivity in $NbSe_2$

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Low-dimensional materials host phenomena absent in their bulk counterparts, including Ising superconductivity in monolayer 1H-$NbSe_2$. Here, strong spin–orbit coupling, together with crystal symmetry, locks the spins of Cooper pairs out of plane and enables in-plane critical fields far exceeding the Pauli paramagnetic limit. Beyond its unusual magnetic-field response, Ising superconductivity is particularly attractive because it can support nontrivial band topology and provide a route toward topological superconductivity. However, the intrinsic instability and fabrication challenges associated with atomically thin materials hinder their practical implementation and integration into devices.

In our work, we show that bulk heterostructures composed of $NbSe_2$ mono- and bilayers separated by spacer monolayers retain a quasi-two-dimensional electronic structure while overcoming the limitations of isolated two-dimensional systems. These bulk compounds exhibit robust Ising superconductivity with in-plane critical fields reaching up to ten times the Pauli limit [1]. By combining structural characterization, magnetotransport measurements, and *ab initio* calculations, we extract band parameters that reveal strongly reduced interlayer coupling and pronounced spin–orbit splitting. These findings provide experimental support for the theoretical framework describing the microscopic origin of Ising superconductivity in bulk compounds [2]. Furthermore, using the 4Ha-$NbSe_2$ polytype as a model system, we demonstrate that inversion-symmetry breaking alone is sufficient to sustain Ising protection in a bulk material, even in the absence of intercalation [3].

Altogether, our results establish a new materials platform that combines the advantages of bulk crystals with the distinctive superconducting properties typically associated with two-dimensional systems. Their bulk nature and structural stability make them particularly well suited for local-probe techniques, enabling direct investigations of the electronic structure and superconducting density of states by scanning tunnelling microscopy.

[1] P. Samuely et al., Phys. Rev. B **104**, 224507 (2021).
[2] T. Samuely et al., Phys. Rev. B **108**, L220501 (2023).
[3] D. Volavka et al., Phys. Rev. Lett. **136**, 016002 (2025).

Multiscale Modeling of Magnonic Devices

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Magnonics provides a promising platform for information processing, ranging from wave-based logic to neuromorphic and quantum devices. However, its development is limited by the lack of predictive frameworks that connect material chemistry to device-scale functionality, particularly beyond conventional systems such as yttrium iron garnet (YIG). We present a multiscale modeling framework that begins with density functional simulations of novel materials and systematically bridges to higher-level theories, enabling the description of complex device architectures. These include systems such as molecular qubits, CpTi[cot], coupled to a monolayer van der Waals magnet, CrSBr [1], as well as tunable magnonic Bragg mirrors controlled through light-induced switching of spin-crossover molecules, Fe–pz [2], adsorbed on the CrSBr surface.

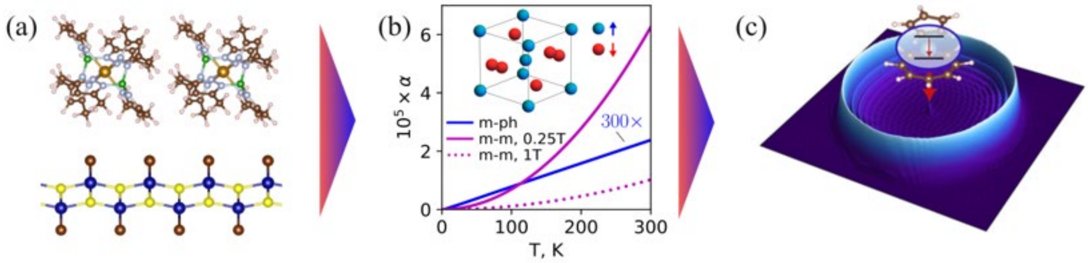

Figure 1 Steps of multiscale modeling: (a) ab initio simulations of materials (Fe-pz molecules adsorbed on CrSBr); (b) calculations of transport and magnetic properties (magnon–magnon and magnon–phonon damping in YIG); and (c) simulations of operating devices (coherent spin waves emitted in monolayer CrSBr by a CpTi(cot) qubit).

As an intermediate stage within this multiscale paradigm, we investigate transport phenomena in magnetic materials, including nonlinear spin-splitting effects in altermagnetic metal–organic frameworks and magnon damping in magnetic insulators arising from magnon–magnon and magnon–phonon scattering processes.

[1] S. Dey, G. Rivero-Carracedo, A. Shumilin, et al, Nano Lett. 25, (2025) 10457.
[2] A. Shumilin, S. Dey, D. Coltuneac, et al, Advanced Materials (2026) e23690.

Altermagnetism and persistent spin textures – can they interfere constructively?

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Altermagnets combine vanishing or negligible net magnetization with momentum-dependent spin splitting of bands, offering interesting opportunities for spintronic functionalities. Because the spin splitting originates primarily from exchange interactions, it can remain large even in materials with moderate spin-orbit coupling (SOC), making altermagnets attractive for efficient charge-to-spin conversion and spin transport [1,2]. In real materials, however, SOC often generates additional spin textures, such as Rashba-like spin-momentum locking, which may compete with and partially obscure the characteristic altermagnetic spin polarization pattern.

In parallel, persistent spin textures (PSTs) have emerged as a promising route toward long spin lifetimes in nonmagnetic materials [3]. The unidirectional spin polarization of PSTs around certain regions of momentum space shares similarities with the nonrelativistic spin texture of altermagnets, raising the possibility of an interplay between the two phenomena.

In this talk, I will discuss the interaction between exchange-driven altermagnetic spin polarization and SOC-induced spin texture of bands in several altermagnet candidates with strong SOC, with particular emphasis on chiral transition metal sulfides TM_3S_6. Depending on the orientation of the Néel vector and the resulting spin texture, SOC contributions can either reinforce or compete with the altermagnetic spin polarization [4]. The consequences for spin textures and charge-to-spin conversion will be discussed, providing insight into the role of spin-orbit coupling in realistic altermagnetic materials.

[1] R. Hirakida, K. Tenzin, C. Chen Ye, B. Kilic, C. Autieri, J. Sławińska, Multipole analysis of spin currents in altermagnetic MnTe, Physical Review B 113, 155104 (2026).
[2] C. Chen Ye, K. Tenzin, J. Sławińska, C. Autieri, Dominant orbital magnetization in the prototypical altermagnet MnTe,
Physical Review B 113, 014413 (2026).
[3] B. Kilic, S. Alvarruiz Campos, E. Barts, B. van Dijk, P. Barone, J. Sławińska, Universal symmetry-protected persistent spin textures in nonmagnetic solids, Nature Communications 16, 7999 (2025).
[4] K. Tenzin, B. Kilic, R. M. Sattigeri, Z. He, C. Chen Ye, M. Costa, M. Buongiorno Nardelli, C. Autieri, J. Sławińska, Persistent spin textures, altermagnetism, and charge-to-spin conversion in metallic chiral crystals TM_3X_6, npj Spintronics 3, 46 (2025).

Tuning The Effective Dzyaloshinskii-Moriya Interaction in CoFeB – Based Heterostructures

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The Dzyaloshinskii–Moriya interaction (DMI) is a key chiral interaction responsible for nonreciprocal spin-wave propagation and the stabilization of chiral magnetic textures in ultrathin magnetic heterostructures. In this work, we demonstrate several complementary routes for controlling the effective DMI in CoFeB-based multilayers by tailoring the ferromagnetic-layer thickness, interface composition, spacer thickness and ion-induced structural modification. The effective DMI is determined from the frequency nonreciprocity of spin waves measured in the Damon–Eshbach geometry.

First, we show that the DMI-induced spin-wave frequency asymmetry depends strongly on the CoFeB thickness. The extracted effective DMI follows an approximately inverse dependence on the ferromagnetic-layer thickness, indicating that the dominant contribution originates from interfaces. Second, we demonstrate that submonolayer interface engineering at the CoFeB/MgO interface enables direct control of the magnitude and sign of the effective DMI. Ultrathin Ta, W, Ru, and Pt insertion layers modify the DMI-induced frequency asymmetry, with Pt insertion reversing its sign. This result shows that the chirality of spin-wave propagation can be reversed by modifying the local interface environment without changing the nominal ferromagnetic-layer thickness.

In Au/CoFeB-based multilayers, we further show that the effective chiral response can be modified by changing the Au spacer thickness and by focused Ga^+ ion irradiation. The spacer-dependent spin-wave nonreciprocity indicates an interplay between interfacial chirality, spacer-mediated coupling and spin-wave mode localization. In contrast, increasing Ga^+ ion fluence progressively reduces the effective anisotropy and effective DMI, eventually driving the system toward nearly reciprocal spin-wave dispersion.

These results demonstrate that the effective DMI in CoFeB-based heterostructures can be engineered through controlled modification of magnetic-layer thickness, interface composition, spacer-mediated coupling and structural disorder. This provides a flexible strategy for designing tunable chiral magnonic systems based on ultrathin magnetic multilayers.

Electronic Transport and Noise Signatures on Superconducting Nanowires Out of Equilibrium

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Superconducting nanowires provide a versatile platform for studying electronic transport in systems where superconductivity, spin-orbit coupling, and magnetic fields interplay. I discuss a nonequilibrium Green's function approach to transport in superconducting nanostructures and its connection to the more familiar Landauer-Büttiker scattering framework [1]. Particular emphasis is placed on Lutchyn-Oreg nanowires, which support topological superconducting phases under suitable conditions [2,3]. The nonequilibrium formulation enables the investigation of both steady-state and time-dependent transport phenomena [4,5]. I present recent results on transient charge transport and current fluctuations, showing how time-resolved currents and nonlocal noise correlations can complement conventional spectroscopic probes and provide access to electron traversal times in superconducting nanowires [6].

[1] M. Ridley, N. W. Talarico, D. Karlsson, N. Lo Gullo, and R. Tuovinen, J. Phys. A: Math. Theor. **55**, 273001 (2022).
[2] R. Lutchyn, J. Sau, and S. Das Sarma, Phys. Rev. Lett. **105**, 077001 (2010).
[3] Y. Oreg, G. Refael, and F. Von Oppen, Phys. Rev. Lett. **105**, 177002 (2010).
[4] R. Tuovinen, E. Perfetto, R. van Leeuwen, G. Stefanucci, and M. A. Sentef, New J. Phys. **21**, 103038 (2019).
[5] R. Tuovinen, New J. Phys. **23**, 083024 (2021).
[6] M. Ridley, E. Cohen, C. Flindt, and R. Tuovinen, Phys. Rev. B **113**, 125433 (2026).

Giant Photoconductance in Infinite-layer Ndnio2/Srtio3 Heterostructures

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The ability to optically manipulate the electronic ground state of complex oxides and their heterostructures holds significant promise, for both fundamental research and technological applications. This field has garnered sustained interest over time. Our work in this area ranges from exploring photo-induced superconductivity in cuprates [1] to investigations of photo-memristive behavior at cuprate/semiconductor interfaces [2].

Here, we focus on the optical generation of two-dimensional electron gases (2DEGs) at oxide interfaces. In addition to unique properties, such as spin-orbit coupling and strong correlations, these 2DEGs present fundamental questions about the microscopic mechanisms underlying their formation. Understanding these mechanisms is essential—and ultimately pivotal—to achieving a long-standing goal: their controlled manipulation through external stimuli.

By integrating experimental observations (transport & STEM-EELS) with density functional theory simulations, we demonstrate that a high-mobility 2DEG can be optically toggled on and off at an oxide interface where such a state does not naturally exist. Specifically, we show that near-ultraviolet illumination instantaneously induces a volatile 2DEG at the interface between $SrTiO_3$ (a band insulator) and infinite-layer $NdNiO_2$ (a poor metal), resulting in a dramatic conductivity increase of up to five orders of magnitude The key ingredients for this effect are the structural and electronic reconstructions at the $NdNiO_2$//$SrTiO_3$ interface, together with a built-in interfacial electric field that promotes the occupation of the Ti $3d_{xy}$ band by the photogenerated carriers [3].

Work supported by EIC Pathfinder "JOSEPHINE" and COST "SUPERQUMAP".

[1] R. El Hage et al., Disentangling Photodoping, Photoconductivity, and Photosuperconductivity in the Cuprates, Phys. Rev. Lett. 132, 066001 (2024).
[2] R. El Hage et al., Bimodal ionic photomemristor based on a high-temperature oxide superconductor/semiconductor junction, Nature Communications 2023 14, 1 (2023).
[3] D. Sanchez-Manzano et al., Giant photoconductance at infinite-layer nickelate/SrTiO3 interfaces via an optically induced high-mobility electron gas, Nature Materials 25, 49 (2026).

Hidden Kekulé Color Index Governs Magnetic Interactions in Graphene

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Here we demonstrate that hydrogen-functionalized graphene provides a versatile platform for exploring atomic-scale magnetism in two dimensions. Using scanning tunneling microscopy, we position individual hydrogen atoms on graphene to create localized spin-1/2 moments [1] and quantify their magnetic coupling through spin excitations measured by inelastic electron tunneling spectroscopy. We observe both ferromagnetic and antiferromagnetic interactions between hydrogen-induced spins, with exchange energies that remain significant over nanometer-scale separations [2].
Beyond the conventional dependence on distance and A/B sublattice configuration, we identify a previously hidden degree of freedom that governs magnetic coupling in this system. This new tuning knob originates from graphene's valley degree of freedom and is encoded in a discrete three-valued Kekulé color index associated with the phase of the interfering electronic wavefunctions.
Mean-field Hubbard calculations and analytical kinetic-exchange models reproduce the observed behavior and reveal the microscopic origin of the Kekulé-color-dependent exchange. We show that the Kekulé color is not merely a weak modulation of the interactions but indeed almost turn them off. This hidden degree of freedom accounts for the unusually long-range nature of the magnetic coupling, its non-monotonic distance dependence, and is expected to govern the distribution of quantum correlations and entanglement monogamy in spin trimers.

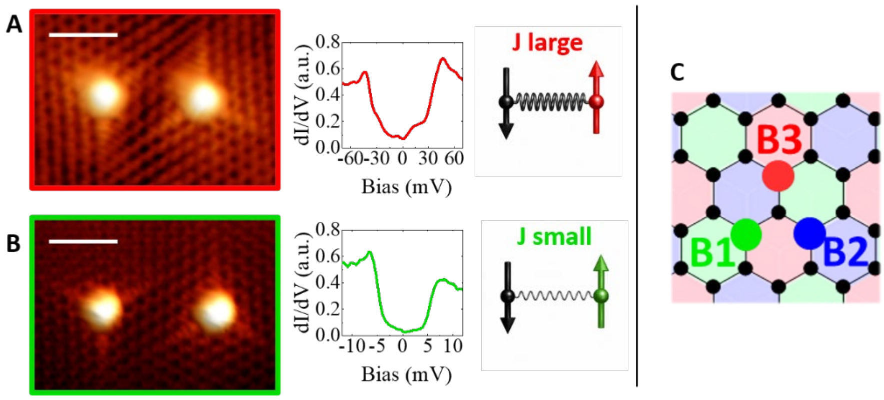

Fig 1. A: AB hydrogen pair in graphene with a large antiferromagnetic exchange coupling. **B:** AB hydrogen pair with a similar geometry and separation to that in A, but a different Kekulé color index, resulting in a much smaller exchange coupling. **C:** Schematic of the tripartite Kekulé color structure arising from intervalley coherence that governs antiferromagnetic coupling in graphene. Scalebar: 2 nm.

[1] H. González-Herrero et al., Science 352 (2016) 437.
[2] B. Viña-Bausá et al., Nat. Commun (2026) doi: 10.1038/s41467-026-72624-0.
[3] Y. Guan et al., Nat. Commun. 15 (2024), 2927.

Moiré Modulated Quantum Spin Liquid Candidate 1T-$TaSe_2$

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Quantum spin liquids are quantum phases of matter featuring collectively entangled states and emergent fractional many-body excitations. While methods exist to probe three-dimensional quantum spin liquids experimentally, these techniques lack the sensitivity to probe two-dimensional quantum spin liquids. This seriously hampers the study of potential monolayer quantum spin liquid candidates such as α-$RuCl_3$ and 1T-$TaSe_2$. Scanning tunneling microscopy (STM) and spectroscopy (STS) have recently been suggested as promising probes of the quantum spin liquid state, as they can access the spinon spectrum through inelastic tunneling spectroscopy (IETS). In this work, we employ this approach on the quantum spin liquid candidate material 1T-$TaSe_2$ and directly measure its low-energy inelastic excitations. We observe the emergence of a $\sqrt{3}\times\sqrt{3}$ reconstruction driven by the substrate, equivalent spectroscopy across all spin sites and coexistence of zero and finite energy excitations. We show that these observations are consistent with a modulated $\sqrt{3} \times \sqrt{3}$ spin liquid ground state. Our results demonstrate that IETS provides a powerful route to obtain atomic-scale insight into the magnetic excitations of two-dimensional materials, allowing to explore the effects of moiré modulations on potential quantum liquid phases.

[1] Lucile Savary and Leon Balents, "Quantum spin liquids: a review," Reports on Progress in Physics 80, 016502 (2017).
[2] Kam Tuen Law and Patrick A Lee, "1T-TaS2 as a quantum spin liquid," Proceedings of the National Academy of
Sciences 114, 6996–7000 (2017).
[3] Wei Ruan, Yi Chen, Shujie Tang, Jinwoong Hwang, Hsin-Zon Tsai, Ryan L. Lee, Meng Wu, Hyejin Ryu, Salman Kahn, Franklin Liou, Caihong Jia, Andrew Aikawa, Choongyu Hwang, Feng Wang, Yongseong Choi, Steven G. Louie, Patrick A. Lee, Zhi-Xun Shen, Sung-Kwan Mo, and Michael F. Crommie, "Evidence for quantum spin liquid behaviour in single-layer 1T-TaSe2 from scanning tunnelling microscopy," Nature Physics 17, 1154–1161 (2021).

Giant Transverse Magnetic Fluctuations at the Edge of Re-Entrant Superconductivity in UTe_2

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Searching for evidence of magnetic fluctuations has become fundamental to understanding the pairing mechanism of unconventional superconductors. One of the most intriguing cases is UTe_2, a paramagnet that hosts multiple superconducting phases, one of which appears beyond 40 T after a metamagnetic transition into a field-polarized phase [1]. Exploration of this exotic superconductivity is particularly challenging given the ultra-high magnetic fields needed, and the few experimental probes compatible with them. We investigate the magnetic anisotropy surrounding the high-field superconducting phases of UTe_2 using resonant torsion magnetometry, which measures the magnetotropic susceptibility [2]. High-quality crystals with $T_c = 2$ K were measured in pulsed magnetic fields up to 60 T in the ac and bc planes in the normal state at T = 4 K. Due to theoscillation of the sample with respect to the magnetic field, this technique directly accesses the transverse magnetic susceptibility. We observe a strong softening of the magnetropic response at approximately 20 T over a wide range of field angles that enhances near the boundary of the high-field superconducting phase [3]. Our results suggest that transverse magnetic fluctuations become significant in this region, providing a likely mechanism for the high field superconductivity in UTe_2.

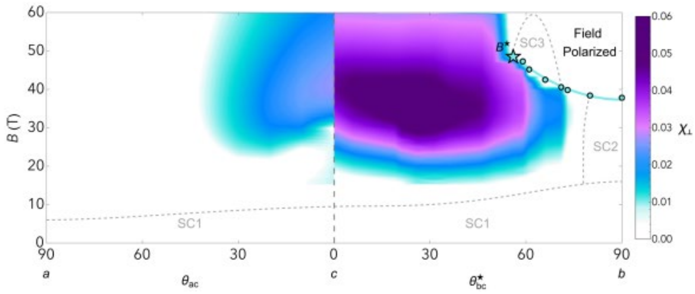

Figure 1: Phase diagram of the magnetotropic susceptibility converted to dimensionless susceptibility units at 4 K [3]. The phase boundaries for SC1, SC2, and SC3 are taken from Lewin et al. [4] and Knebel et al. [5] at 300 mK.

[1] S. Ran et al., Nature Phys. 15 (2019), 1250.
[2] A. Shekhter et al., Phys. Rev. B 108 (2023), 035111.
[3] V. Zambra et al., Nat. Commun. 17 (2026), 3742.
[4] S. K. Lewin et al., Science 389 (2025), 512.
[5] G. Knebel et al., J. Phys. Soc. Jpn. 88 (2019), 063707.

Abstracts- Contributed

Meisssner Response of Odd-frequency Superconductors

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In our work [1], we investigate the role of quantum geometry in the Meissner response for odd-frequency superconducting pairs in multiband systems. Odd-frequency pairing is traditionally associated with a paramagnetic Meissner response, which raises questions about the stability of the superconducting phase, especially in multiband systems where odd-frequency pairing is ubiquitous. Using analytical calculations in a general two band, we show that the quantum geometric contribution to the Meissner response from odd-frequency pairs is always diamagnetic for its interband processes, while intraband processes always yield a paramagnetic response. With odd-frequency pairing itself generated by interband pairing, an overall diamagnetic response may often be anticipated. We confirm these results with numerical calculations of models with both flat and dispersive bands. In flat-band systems, where geometric effects dominate, the diamagnetic odd-frequency response can even exceed the even-frequency contribution, making odd-frequency pairs the primary source of the diamagnetic Meissner response. In a dispersive two-band system with finite quantum geometry, we similarly find a robust diamagnetic contribution from odd-frequency pairing, even when the total response turns paramagnetic due to even-frequency contributions. Overall, our results demonstrate that quantum geometry can stabilize odd-frequency superconductivity and identify flat-band systems as promising platforms for realizing a diamagnetic Meissner effect.

[1] Ankita Bhattacharya and Annica M. Black-Schaffer, Phys. Rev. B. 113, 094501 (2026).

Topology of multi-terminal Josephson junctions with interacting two and three quantum-dot systems

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In the past few years, multi-terminal Josephson junctions have attracted considerable attention due to their non-trivial topological properties [1,2]. Theoretical predictions of topological Andreev bands have now been confirmed in four-terminal Josephson-junction heterostructures that were modeled using three quantum dots [3]. However, theoretical descriptions of these complex devices are typically restricted to the non-interacting limit, while on-site Coulomb interactions can be sizable in realistic systems. We have recently introduced the Chain Expansion (ChE) method [4], which maps each superconducting lead onto a short tight-binding chain. The resulting effective models enable a controlled treatment of complex interacting structures at a reasonable computational cost. Here, we apply ChE to systems of two and three quantum dots coupled to multiple superconducting leads. We first demonstrate that, in the non-interacting limit, the topology agrees with established predictions. We then analyze how the topological features evolve as interactions are turned on in both the atomic-limit and realistic-superconducting gap regimes.

[1] D. C. Ohnmacht, et.al, Phys. Rev. Lett. 134, 156601, 2025.
[2] D. C. Ohnmacht, et.al, Phys. Rev. B 109, L241407, 2024.
[3] T. Antonelli, et.al, Phys. Rev. X 15, 031066, 2025.
[4] D. Bobok, et.al, Phys. Rev. B 112, 205418, 2025.

Low-Dimensional Critical Behavior of Correlated Electrons, Mermin-Wagner Theorem, and Local Self-Energy

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We present a theoretical treatment of low-dimensional critical behavior coming from electron correlations. The treatment is based on the Baym-Kadanoff approach, which involves one-particle self-consistency between the propagator and the self-energy while leaving the bare two-particle interaction unchanged. In low dimensions, self-consistency prevents ordering, in agreement with the Mermin-Wagner theorem, and exhibits critical behavior as the temperature is lowered towards zero. The nonintegrability of the superconducting susceptibility allows the use of the polar approximation, which reduces the convolutive Schwinger-Dyson equation to an algebraic equation for the local propagator and self-energy, thereby making it amenable to solution. We demonstrate our treatment on the example of a 1D Hubbard model with an attractive interaction, which describes the tendency toward superconductivity, in the FLEX approximation. We have analytically confirmed and numerically demonstrated uncorrelated critical behavior above the mean-field critical temperature and strongly correlated critical behavior below it, with a crossover between the two. As expected, the solution remains metallic down to zero absolute temperature.

Chemical Engineering of Altermagnetism in Metal-Organic Frameworks

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The recent identification of altermagnetism as a distinct magnetic phase has opened a new conceptual framework for spin-dependent phenomena beyond conventional ferro- and antiferromagnetism,[1] yet its realization has so far been largely restricted to a relatively narrow set of inorganic materials.[2] In contrast, molecular systems—and in particular metal–organic frameworks (MOFs)—provide an unexplored chemical space as a platform for emergent magnetic phenomena.[3] In these systems, magnetic order, exchange interactions and, crucially, symmetry can be precisely engineered. Here, we demonstrate that low-dimensional MOFs can host altermagnetic behavior, giving rise to spin-split electronic structures in the absence of net magnetization. In these systems, symmetry plays a central role in defining the emergence of altermagnetic states, highlighting how electronic structure can be controlled through chemical design.[4] Furthermore, we show that altermagnetism can be intrinsically coupled to spin crossover in MOFs, providing a route toward switchable altermagnetic materials. These results position MOFs as a promising and highly adaptable platform for extending altermagnetism into the realm of molecular magnetism and open new perspectives for the design of spintronic functionalities in chemically programmable materials.[5].

[1] Šmejkal, L.; et al. Phys. Rev. X, 12 (2022), 040501.
[2] Song, C.; et al. Nat. Rev. Mat., 10 (2025), 473–485.
[3] Thorarinsdottir, A. E.; Harris, T. D. Chem. Rev., 120 (2020), 8716–8789.
[4] López-Alcalá, D.; et al. J. Am. Chem. Soc. (2026).
[5] López-Alcalá, D.; et al. arXiv 2603.05112, 2026.

Robust Two-dimensional Surface Superconductivity and Vortex Lattice in the Weyl Semimetal γ-$PtBi_2$

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The layered compound γ-$PtBi_2$ is a topological semimetal with Fermi arcs at the surface joining bulk Weyl points. Recent work has found signatures of surface superconductivity consisting of gap openings compatible with a critical temperature orders of magnitude larger than the bulk value. However, no superconducting vortices have been identified, raising questions about the robustness of the phase coherence. Here we use very low temperature Scanning Tunneling Microscopy (STM) and find robust superconductivity with T_C =2.9 K and H_{C2} ≈1.8 T linked to the Fermi arcs. We observe quantized superconducting vortices and the Josephson effect, demonstrating two-dimensional macroscopic quantum phase coherence.

[1] J. A. Moreno *et al.* arXiv:2508.04867v2 (2026).

Mobile Impurity Across the Fulde-Ferrell-Larkin-Ovchinnikiv Phase Transition

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The Fulde–Ferrell–Larkin–Ovchinnikov (FFLO) state is a superconducting phase characterized by finite centerof-mass momentum of Cooper pairs and a spatially modulated order parameter [1, 2]. Its experimental identification remains difficult because the phase is stable only in a narrow parameter regime, and its spatial modulation is not directly visible to most bulk probes. Mobile impurities have emerged as powerful microscopic probes of ultracold gases, as their quasiparticle energy and spectral response are strongly influenced by the surrounding medium [3]. At the same time, ultracold gases offer a clean and tunable platform for investigating FFLO physics. We study a mobile impurity coupled to a spin-imbalanced Fermi superfluid and explore its use as a probe of the BCS–FFLO–normal phase transitions. We use a Fulde–Ferrell mean-field description of the host medium and a variational theory for the impurity, which leads to a closed set of three coupled integral equations. We show that the finite pairing momentum transforms the polaron pole from a bound state below the continuum (as found in the BCS regime) into a resonance inside the continuum with a finite decay width. This behavior is reflected in Fig. 1, where the impurity spectral function exhibits pronounced changes upon entering the FFLO regime. As shown in Fig. 2, the polaron energy and residue display abrupt jumps at the first-order BCS-to-FFLO transition, whereas they evolve smoothly across the FFLO-to-normal transition. These features provide impuritybased signatures of FFLO pairing that can be probed with Ramsey spectroscopy.

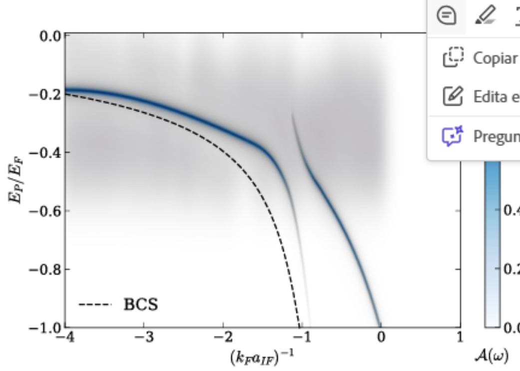

Fig 1. Impurity spectral function for the FFLO phase as a function of $1/(k_F a_{\mathrm{fi}})$. The dashed line traces the lowest bright polaron branch for BCS phase.

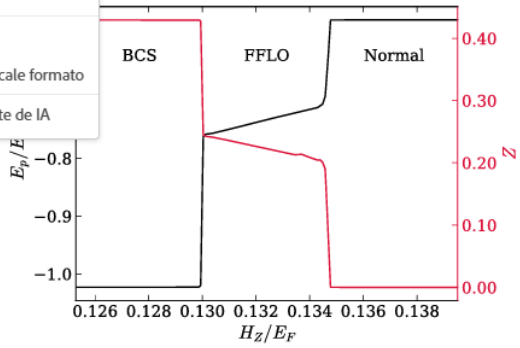

Fig 2. Impurity energy (black) and residue (red) across the BCS-FFLO-normal phase evolution at $1/(k_F a_{\mathrm{fi}}) = -1$.

[1] P. Fulde and R. A. Ferrell, Phys. Rev. 135 (1964) A550.
[2] A. I. Larkin and Yu. N. Ovchinnikov, Sov. Phys. JETP 20 (1965) 762.
[3] R. Alhyder and G. M. Bruun, Phys. Rev. A 105 (2022) 063303.

Thermal Control of Structure, Magnetic Anisotropy, and Gilbert Dampling in Epitaxial Co_2FeGe Heusler Alloy Films

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Epitaxial Co_2FeGe full-Heusler alloy thin films (≈60 nm) were deposited on MgO(001) single-crystal substrates by dc magnetron co-sputtering. The influence of thermal processing on their structural, static magnetic, and dynamic magnetic properties was systematically investigated through variation of the substrate temperature (T_S = RT, 573, and 773 K) and post-deposition annealing of room-temperature-grown films (T_a = 573 and 773 K). X-ray diffraction reveals high-quality (001)-oriented epitaxial growth with the epitaxial relationship Co_2FeGe(001)[110] ‖ MgO(001)[100]. Due to lattice mismatch, films deposited at room temperature exhibit a tetragonal distortion ($c/a \approx 0.985$), which gradually relaxes with increasing T_S or T_a while maintaining an almost constant unit-cell volume. The emergence of superlattice reflections at elevated processing temperatures indicates the development of $L2_1$ chemical ordering.

SQUID magnetometry shows a systematic increase in saturation magnetization with increasing T_S and T_a, reflecting enhanced atomic and epitaxial order. Ferromagnetic resonance measurements reveal a 45° rotation of the in-plane easy axis, from the [110] to the [100] crystallographic direction, as the tetragonal distortion is reduced, highlighting the significant role of magnetoelastic effects in determining the cubic magnetic anisotropy. The Gilbert damping parameter exhibits a pronounced non-monotonic dependence on thermal treatment. The room-temperature-grown film annealed at 573 K displays the lowest damping ($\alpha \approx 4 \times 10^{-3}$) together with minimal extrinsic linewidth broadening. In contrast, higher deposition or annealing temperatures lead to increased damping and inhomogeneous linewidth broadening, likely associated with defect formation and compositional inhomogeneities.

These results demonstrate that moderate thermal processing provides an effective route to optimize both magnetic anisotropy and dynamic response in epitaxial Co_2FeGe films, establishing this material as a promising platform for low-damping spintronic and magnonic applications.

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Abstracts- Poster

Structural, Magnetic, and Magnetocaloric Properties of Ti-Substituted GdMnO3 Multiferroic Single Crystals

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$GdMnO_3$ came to the attention of the scientists due to the discovery of multiferroicity in this compound. It crystallizes in the orthorhombically distorted perovskite structure; space group $Pnma$; Gd ions are located on $4c$; Mn ions on $4b$ and oxygen anions are located on $4c$ and $8d$ crystallographic sites. The compound orders into antiferromagnetic phase below TN ~ 40 K [1] and then undergoes order-to-order magnetic phase transition into low temperature canted magnetic phase at Tlock (~ 20 K). GdMn1-xTixO3 ($0 \leq x \leq 0.1$) compounds were synthesized by the floating zone method to understand the role of Ti substitution on structural, magnetic, and magnetocaloric properties. Raman spectroscopy and X-ray diffraction, along with Rietveld refinement, confirm the pure phase of all compositions having an orthorhombic perovskite structure (space group; Pnma). The Neel temperature TN is not visible on magnetization measurements; however, from the combination of zero-fieldcooled; field-cooled magnetization data and hysteresis loops M(B), we concluded the decrease of TN from 42 K (x = 0) to roughly 30 K (x = 0.1). Tlock has been also shifted from ~20 K (x = 0) to ~2 K (x = 0.1). In the temperature interval Tlock < T < TN the M(B) curves show simple antiferromagnetic behavior, however, below Tlock the character of M(B) curves changed from complicated butterfly-type (x = 0) to simple ferromagnetic one (x = 0.1). This suggests that Ti destabilizes the magnetic structure or at least prevents the Gd sublattice from ordering. Magnetic entropy change (ΔSM) is extremely sensitive to the direction of the applied field and can be negative (normal MCE) or positive (inverse MCE). The Gd ordering induces an inverse MC effect along 'c' and 'b' axes, whereas it's not seen along the 'a' axis, revealing complex anisotropic magnetic ordering. The magnetic entropy change displays a broad peak at T1 ~ 13 K with -ΔSM = 11.35, 8.05, and 7.77 J/kg-K and corresponding relative cooling power (RCP) = 197.72, 164.70, and 166.78 J/kg for x = 0.0, 0.05, and 0.1, respectively, under 5 T. A sharp -ΔSM = 0.55 J/kg-K (0.5 T) appears at Tlock = 20 K (x = 0.0), which is shifted to higher temperatures with a magnetic field. The large cryogenic MCE suggests these compounds are promising for low-temperature magnetic refrigeration applications.

Acknowledgements
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[1] N. Pavan Kumar et al., Phys. Scr., Vol. 83, p.045701 (2011).

STM measurements on atomically resolved As-terminated surfaces of $CaKFe_4As_4$

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$CaKFe_4As_4$ is a stoichiometric iron-based superconductor with a relatively high critical temperature of approximately 35 K. Its superconductivity is commonly described as multiband, nodeless s± pairing. This combination is believed to play a key role in achieving such a high critical temperature. However, the microscopic origin of superconductivity in iron pnictides remains an open question. Scanning Tunneling Microscopy (STM) studies at millikelvin temperatures in $CaKFe_4As_4$ provide strong support to the established view of a multiband, nodeless s± pairing system, from measurements of the superconducting gap and the vortex lattice. In vortex cores, Majorana modes have been proposed to emerge [1]. However, experiments are mostly done on Ca- and K-terminated surfaces, which often do not display atomic resolution [2]. In this work we perform STM measurements at 100 mK on atomically resolved surfaces of $CaKFe_4As_4$ to investigate the atomic scale spatial modulations of the electronic structure. We identify different surface terminations and carry out quasiparticle interference (QPI) measurements on As-terminated surfaces to probe the electronic properties near the superconducting gap. These atomically resolved surfaces exhibit vacancies which strongly modify the local density of states and influence the density of states in vortex cores. Our results highlight the importance of atomic-scale defects in shaping the local density of states observed by STM.

[1] Z. Zhang, *et al.*, *Commun Phys* **9**, (2026) 11.
[2] A. Fente, *et al.*, *Phys. Rev. B*, **97** (2018) 134501.

Josephson Junctions For Operation Under High Fields And High Frequencies

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Conventional Josephson junction (JJ) technologies face important limitation when operated under high magnetic fields and at microwave frequencies. Developing alternative weak-link designs capable of maintaining their performance under these conditions is therefore essential for future quantum sensing and superconducting microwave applications.

In this work, we investigate two JJ technologies integrated into nano-SQUID devices. The first approach employs grain-boundary junctions in YBCO (YBa2Cu3O7-δ) thin films grown by pulsed laser deposition (PLD) on MgO bicrystal substrates. MgO low microwave losses make it particularly attractive for high-frequency applications. In these devices, the grain-boundary 24º misorientation of the substrate naturally defines the Josephson weak link.[1]

The second approach is based on constriction Josephson junctions fabricated in Nb using Helium Ion Microscopy (HIM). Unlike grain-boundary junctions, where the weak link is generated by a crystallographic discontinuity, constriction junctions rely on a nanoscale reduction of the superconducting channel width. HIM offers direct-write nanofabrication with nanometric resolution and precise control of the weak-link geometry, enabling the realization of compact nano-SQUIDs compatible with microwave environments.[2]

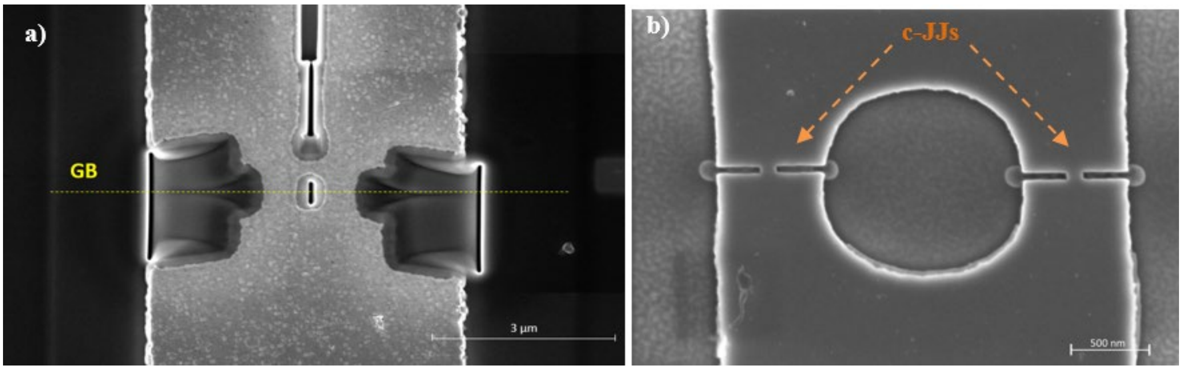

Figure 1: a) YBCO grain-boundary nano-SQUID. b) Nb nano-SQUID with HIM-fabricated constriction junctions.

Future work will focus on the optimization of these nano-SQUIDs, as well as on their integration into superconducting resonators for broadband microwave measurements.

[1] H. Hilgenkamp and J. Mannhart, Rev. Mod. Phys. 74 (2002) 485–549.

[2] B. Müller, M. Karrer, F. Limberger, M. Becker, B. Schröppel, C. J. Burkhardt, R. Kleiner, E. Goldobin and D. Koelle, Phys. Rev. Appl. 11 (2019) 044082.

Organic ion intercalation of the antiferromagnet vdW CrSBr for tuning ferromagnetism above 200 K

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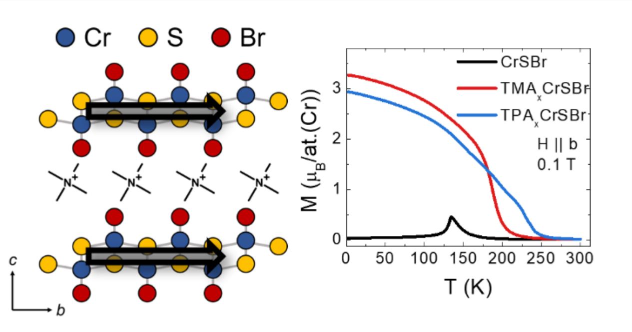
Van der Waals (vdW) magnets are promising for spintronic applications, but their low intrinsic magnetic ordering temperatures hinder practical implementations. Here, we demonstrate a strategy to induce ferromagnetism at high transition temperatures in the air-stable layered antiferromagnet CrSBr [1] through galvanic molecular intercalation [2].
By introducing tetramethylammonium (TMA) and tetrapropylammonium (TPA) cations between CrSBr layers, we modify the interlayer exchange interactions, stabilising a robust ferromagnetic phase [3]. Magnetisation measurements confirm the emergence of long-range ferromagnetic order in intercalated CrSBr (Figure 1), with an enhanced Curie temperature compared to the Néel temperature of pristine CrSBr. Density of states calculations reveal a transition from an antiferromagnetic to a spin-polarised ferromagnetic state, driven by changes in interlayer coupling. X-ray diffraction shows an expansion of the van der Waals gap upon intercalation, which can be linked to the magnetic transition. Raman spectroscopy further supports this phase change, with shifts in vibrational modes reflecting structural modifications. Additionally, electrical transport measurements reveal intercalation-induced modifications in magnetoresistance, consistent with the emergence of a ferromagnetic state.
Our results establish galvanic molecular intercalation as an effective tool for engineering ferromagnetism in vdW materials, enabling higher transition temperatures and tuneable magnetic properties. This work provides a pathway toward integrating two-dimensional magnets into spintronic and quantum devices, overcoming fundamental temperature limitations in vdW magnetism.



[1] Ziebel, Michael E., et al. "CrSBr: an air-stable, two-dimensional magnetic semiconductor." Nano letters 24.15 (2024): 4319-4329.
[2] Tezze, Daniel, et al. "Galvanic intercalation of molecular cations into van der Waals materials and heterostructures." Nature Synthesis 5.3 (2026): 388-397.
[3] Ferreira-Teixeira, Sofia, et al. "Ferromagnetism above 200 K in organic-ion intercalated CrSBr." ACS Nano 19.41 (2025): 36275-36284.

Layered Vanadium Trihalides with sizable Orbital Moment

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Highly anisotropic layered magnets provide an interesting platform for the tuning and manipulation of magnetic properties. CrI_3 was the first 2D material with magnetic order persisting down to the monolayer limit, owing to its strong perpendicular magnetic anisotropy. Vanadium trihalides, VX_3 (X = I, Br, Cl), are a family of van der Waals magnets analogous to CrX_3 compounds that exhibit strong spin-orbit coupling and tunable electronic properties. While the orbital moment in CrX_3 is quenched, a substantial orbital angular momentum has recently been found in VI_3 [1] and is also expected in other vanadium halides. Although VI_3 is now a well-characterized ferromagnet with a resolved ground state and orbital magnetism, the structure and orbital magnetism of antiferromagnetic VBr_3 are still under debate [2, 3], and the interplay between orbital and spin magnetism remains poorly understood. We address this by combining X-ray magnetic circular dichroism (XMCD) measurements with ligand field multiplet (LFM) and density functional theory (DFT) simulations to reveal the electronic ground state in VBr_3. Orbital ordering presents yet another degree of freedom that needs to be taken into consideration in the VX3 family [4], emphasizing the need for a systematic theoretical study. We utilize DFT+U+SOC approach to account for electron correlation and calculate the electronic and magnetic properties for several orbital configurations. XMCD and X-ray linear dichroism (XLD) measurements provide direct evidence of unquenched orbital moments on vanadium sites, which we compare with results from LFM and electronic structure calculations. Furthermore, exchange parameters and magnetic anisotropy are obtained, and the role of V-Br hybridization is explored. Finally, our work contributes to the understanding of electronic ground state of VBr_3 and the interplay between orbital and spin magnetism in vanadium trihalides.

[1] D. Hovancik, J. Pospisil, K. Carva, V. Sechovsky, and C. Piamonteze, Nano Lett. 23 (2023), 1175-1180
[2] Y. Gu, Y. Hao, Z. Kao, Y. Gu, F. Liu, S. Zheng, H. Cao, L. He, and J. Zhao, Phys. Rev. B 110 (2024), 064403.
[3] M. Klicpera, O. Michal, D. Hovancik, K. Carva, O. R. Fabelo Rosa, M. Orlita, V. Sechovsky and J. Pospisil, J. Alloys Compd. 1008 (2024), 176544
[4] I. V. Solovyev, R. Ono, and S. A. Nikolaev, Phys. Rev. B, 110 (2024) 205116.

Magnetic and magnonic properties of Cr_2S_3 and Cr_2Se_3 monolayers

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Two-dimensional magnetic materials are promising platforms for magnonic technologies where spin waves enable low-dissipation information transport and processing [1,2]. Identifying experimentally accessible systems that combine robust magnetic order, efficient spin-wave propagation and tunable magnonic properties remains a key challenge. Recently synthesized Cr_2S_3 [3] and Cr_2Se_3 [4] monolayers satisfy many of these requirements, as both systems exhibit relatively high magnetic ordering temperatures (~200 K) and distinct magnetic ground states, with ferromagnetic Cr_2Se_3 and antiferromagnetic Cr_2S_3 [5,6]. Here, we investigate the magnetic and magnonic properties of Cr_2S_3 and Cr_2Se_3 from first principles. We show how ligand substitution effectively tunes the exchange interactions, stabilizing distinct magnetic ground states in each monolayer. Despite their different orders, both systems support highly dispersive magnon modes, indicating robust spin-wave propagation. A key distinction arises in magnon reciprocity: Cr_2Se_3 exhibits intrinsic nonreciprocal spin-wave dispersions due to symmetry breaking, whereas Cr_2S_3 remains reciprocal. However, an external electric field breaks the protecting symmetry in Cr_2S_3, inducing nonreciprocal magnons and enabling the reversal of this reciprocity via field polarity, thus allowing electrically tunable directional magnon transport. Our results highlight these materials as promising candidates for two-dimensional magnonics and provide a route toward electrically controlled magnonic devices.

[1] A. Barman et al., J. Phys. Condens. Matter, vol. 33, no. 41, p. 413001, Aug. 2021.
[2] S. Mañas-Valero, T. van der Sar, R. A. Duine, and B. van Wees, Newton, vol. 1, no. 1, Mar. 2025.
[3] A. Safeer et al, Adv. Funct. Mater., vol. 35, no. 49, Dec. 2025.
[4] Y. Zhang et al., Adv. Mater., vol. 31, no. 19, p. 1900056, 2019.
[5] A. Safeer et al., Apr. 08, 2026, arXiv: arXiv:2604.07245. doi: 10.48550/arXiv.2604.07245.
[6] C.-W. Chuang et al., Nat. Commun., vol. 16, no. 1, p. 3448, Apr. 2025.

Conductance Of Atomic Size Contacts of Ag and Au at High Magnetic Fields

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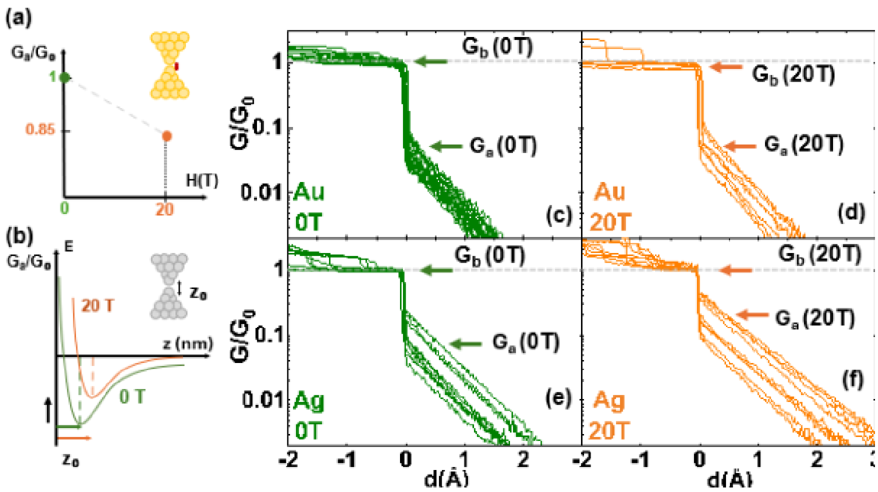
Electronic conduction at the atomic scale can be described by Landauer's formalism. In single-atom point contacts of noble metals like Au and Ag, there is just one channel open between both electrodes and the conductance is very close to the quantum of conductance $G \approx G_0 = 2e^2/h$, with the factor of two coming from spin degeneracy. The magnetoconductivity of atomic size contacts has been studied for numerous systems, unveiling local Kondo screening, magnetic order, and spin-polarized currents. However, these have been mostly performed in elements with multiple open conduction channels where G differs from G_0. The realization of a magnetically active conductor with a single-open channel remains difficult to achieve. Here, we present measurements of the electronic conductance of single-channel Au and Ag atomic size contacts in magnetic fields up to 20 T. We observe a decrease in G which goes up to about 15% in many Au contacts at 20 T. We perform calculations and find that pure Ag and Au do not present a strong field dependence of G, in agreement with previous results at smaller magnetic fields. We also find, however, that residual O_2 molecules attached close to the contact produce an induced spin-polarized current, which leads to a decrease in G. We discuss the role of the magnetic response of the electrodes in the jump-to-contact. Our results suggest that single channel atomic size conductors with a sizable response to a magnetic field can be built by combining noble metals and magnetically active molecular systems.



[1] B. Wu, et al., Phys. Rev. Research **8**, 013091 (2026).
[2] M. Calvo, et al., Phys. Rev. Lett., **120**, 076802 (2018).
[3] C. Sabater, et al., Nanoscale Res. Lett., **8**, 257 (2013).
[4] C. Sabater, et al., Phys, Rev. Lett., **97**, 075418 (2018).

Scanning Tunneling Microscopy of the Vortex Lattice and Electronic Structure of the Superconductor FeSe

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This work presents a study of the iron-based superconductor FeSe, a material known to exhibit unconventional superconductivity, a structural transition, and electronic nematicity. By using Scanning Tunneling Microscopy (STM) inside a ^3He-^4He dilution refrigerator, we characterized its properties with atomic resolution down to mK temperatures. This experimental setup allowed us to acquire conductance curves to measure the electronic density of states with an energy resolution in the μeV range.

Surface characterization revealed both twin boundaries and various types of distinct defects. Furthermore, we conducted a dual spectroscopic study: first, we analyzed the Abrikosov vortex lattice under an applied magnetic field of 8 T, estimating an inter-vortex distance that aligns closely with theoretical predictions; second, we performed a quasiparticle interference (QPI) study at 15 T enabled by defect scattering, allowing us to distinguish an electron-like band and a hole-like band with a Fermi energy of just a few meV.

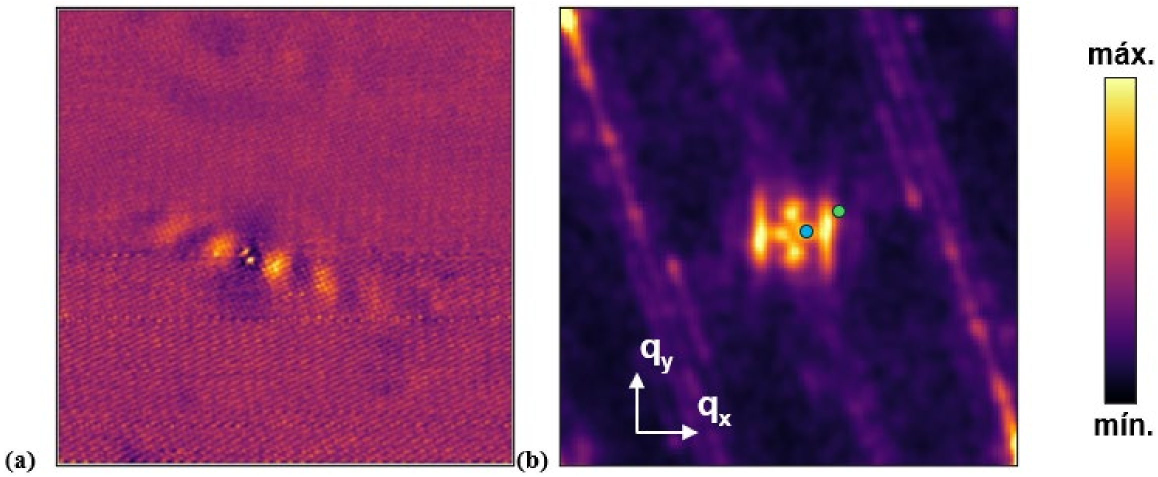

Figure 1. STS measurements of an area of 30.1 × 30.1 nm^2 around a defect, at T=1.1 K and under B=15 T. The measurements were taken at a 1 nA set-point. **(a)** Conductance map at V=0 mV. **(b)** Fourier Transform map (FFT) of **(a)**. Main scattering directions are indicated with white arrows. Blue and green dots in the FFT maps mark the main scattering points.

Scanning Tunneling Microscopy in high vectorial magnetic fields

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Cryogenic Scanning Tunneling Microscopy (STM) has been instrumental in the development of scanning probe microscopies. The addition of a magnetic field opens new prospects, such as the observation of vortex lattices in superconductors or of Landau quantization. For the latter, it is of particular importance to decrease as far as possible the size of the STM. Although efforts made during past years have led to some improvements, the size is still far above the typical sizes available for instruments used in high magnetic fields. Here we discuss the development of both a reduced size STM and a rotating platform meant to obtain measurements at different angles between the sample and the magnetic field[1]. This feature will allow us to observe new exotic phases emerging at high tilted magnetic fields, unreachable using state of the art three-axis coils [2]. Both the head and the base of the main body of the STM have been manufactured through 3D printing in grade 3 Titanium, which could turn out to be a good method to optimize the weight without modifying too much the stiffness of the microscope. Finite element calculations of the 3D printed system support the latter aspect. The STM has a diameter of 16 mm and a height of 25 mm. We have successfully tested the stability of the system by reproducing millions of atomic-sized gold junctions at fields of 8 T in different orientations. We have also obtained images of the tilted vortex lattice and achieved atomic resolution in 2H-NbSe2, demonstrating the proper functioning of the rotatory system together with the STM. Having set-up this ultra-small size STM will also allow its use in high magnetic field facilities. Further improvements, as the construction in shapal or ceramics to avoid Joule heating, are on the way.

[1] J. Rumeu Ozores, *et al.*Rev. Sci. Instrum. 97, 033705 (2026).
[2] F. Martín Vega, *et al.* Rev. Sci. Instrum. 92, 103705 (2021).

Disorder-induced superconductivity in graphene

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Graphene is a highly tunable platform for exploring low-dimensional quantum phases, but its semi-metallic nature dictates that superconductivity requires exceeding a quantum critical electronic interaction strength. Although vacancies in graphene are known to generate a high density of low-energy states, the impact of this disorder on ordered phases remains unresolved. Here, we establish that such chiral disorder drives robust, phase-coherent superconductivity. For conventional on-site pairing, disorder induces a finite superconducting order parameter for arbitrarily weak interactions. Rather than forming isolated puddles, the system establishes global phase coherence through a finite superfluid weight of purely geometrical origin. Away from the chiral limit, hydrogenation similarly yields a finite transition temperature and nonzero superfluid weight for weak interactions. Conversely, for unconventional nearest-neighbor pairing, phase coherence exhibits quantum-critical-like behavior, yet a finite Berezinskii–Kosterlitz–Thouless transition temperature persists in both pairing channels. Our results demonstrate the possibility of superconductivity driven entirely through disorder.