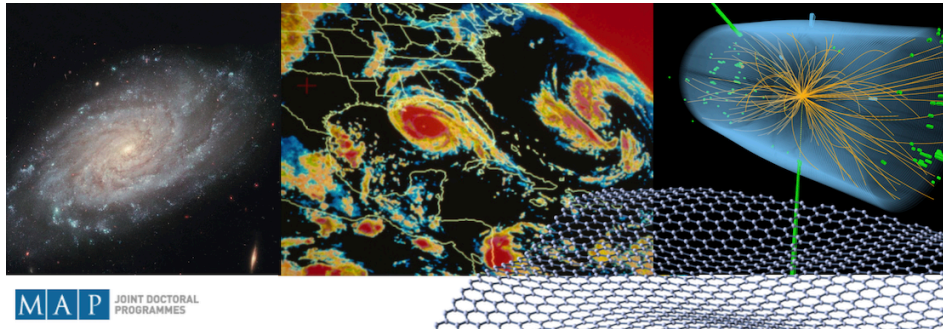


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School of Sciences, University of Minho



Book of Abstracts

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High Energy Physics and Cosmology I (Chair: Ricardo Z. Ferreira, UM) / 177**Non-Minimally Coupled Chain Inflation at High Scales****Author:** Miguel Barroso Varela¹**Co-authors:** Evangelos Sfakianakis ; Katherine Freese ; Orfeu Bertolami¹ *Centro de Física do Porto - University of Porto*

Chain inflation offers an alternative to standard slow-roll dynamics, with accelerated expansion proceeding through a sequence of rapid quantum tunneling events between metastable vacua. At the high energy scales relevant for the early Universe, scalar fields are generically expected to couple non-minimally to gravity via operators like $\xi R\phi^2$, allowed by symmetry and required as counterterms for interacting theories in curved spacetime. We study the dynamical and observational consequences of this coupling for chain inflation. We find the modifications to the model for arbitrary ξ and focus on interesting phenomenology for $\xi = \mathcal{O}(10)$. We show that, in the Einstein frame, the non-minimal coupling induces a field-dependent amplification of the Euclidean bounce action, thus modifying the tunneling rate across the chain. We develop an analytic framework connecting this modified tunneling dynamics to the scalar spectral index, its running, the primordial curvature power spectrum, and the stochastic gravitational wave background from bubble collisions. As one consequence, the non-minimal coupling breaks the rigid relation between the scalar tilt and inflationary scale that drives the minimally coupled pure tilted cosine model to very low energies ($V_*^{1/4} \lesssim 3 \text{ GeV}$, where V_* is the value of the inflationary potential when the CMB-relevant modes exit the horizon), allowing for viable high-scale chain inflation with $V_*^{1/4} \sim 10^{11} \text{ GeV}$. Furthermore, non-minimally coupled chain inflation at high scales produces a peaked stochastic gravitational wave signal in the dHz-kHz bands, accessible to upcoming interferometers such as the Einstein Telescope and Cosmic Explorer. Finally, the model predicts a distinct running of the spectral index that will be testable by the Simons Observatory, making it a prime target for multi-messenger cosmology. Based on 2607.27193.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

University of Porto

Condensed Matter Physics and Nanomaterials II (Chair: André Chaves, UM) / 178**Optical Signature of Bulk Vacancies in Nodal Line Semimetals****Author:** João Santos Silva¹**Co-authors:** Eduardo Castro ²; Miguel Araújo ³; Vitor Pereira ²¹ *CF-UM-UP, Centro de Física do Porto, FCUP*² *CF-UM-UP, Faculdade de Ciências, Universidade do Porto*³ *CeFEMA, Instituto Superior Técnico, Universidade de Lisboa. Universidade de Évora, Departamento de Física*

Weyl nodal loop semimetals are topological semimetals where the valence and conduction bands linearly touch along one dimensional loops in momentum space. A manifestation of their non-trivial topology is the presence of zero energy surface states, induced by chiral symmetry, on surfaces parallel to the loop plane. Unlike their insulator counterparts, these exotic phases may be unstable

to small perturbations that respect their topology-protecting symmetries. Results for symmetry-breaking disorder have been reported. However, the case of vacancies preserves the underlying symmetry, and remains largely open.

Here, we will discuss the effects of vacancies in the bulk of a nodal loop semimetal tight-binding model, as well as an effective low energy model for a circular nodal loop, where an analytical approach is tractable. We focus on the changes in the density of states (DOS), computed via a projected Green's function formalism, and study the linear optical conductivity in the presence of vacancies. A single cell-vacancy creates broad peaks near the Fermi level, but the system remains a semimetal, whereas site-vacancies induce a sharp peak at zero energy.

The optical conductivity in the presence of site vacancies has a sharp absorption edge at $\omega = E_F$, followed by a power law decay which, for a single vacancy, goes as $\sim 1/\omega^2$. The cell vacancy case reveals a complete vanishing of the optical gap.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Condensed Matter Physics and Nanomaterials II (Chair: André Chaves, UM) / 179

Real-Space Theory of Nonequilibrium Orbital Magnetization in Non-crystalline Systems

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The nonequilibrium generation of orbital magnetization by applied electric fields is a central problem in the emerging field of orbitronics [1,2]. Its theoretical description, however, is challenging because the conventional expression for orbital magnetization involves the position operator, which is ill-defined under periodic boundary conditions. Although the modern theory of orbital magnetization overcomes this difficulty by reformulating the problem in terms of Bloch states [3], its extension to nonequilibrium systems and beyond the clean-crystal limit [4,5] remains incomplete.

Here, we present a general real-space formalism for nonequilibrium orbital magnetization that avoids explicit use of the position operator and is directly applicable to systems lacking perfect translational symmetry, including disordered and quasiperiodic materials. The orbital magnetization response is extracted from the current-current response function at first order in the wave vector of the applied electric field and is formulated entirely in terms of traces of operators in a basis-independent manner. The resulting expressions are manifestly gauge invariant and position-independent. The trace-based formulation is ideally suited to large-scale numerical calculations using the Kernel Polynomial Method, enabling simulations of system sizes that are inaccessible to conventional approaches and providing an efficient framework for investigating disorder effects. We demonstrate the versatility of the formalism through numerical tight-binding calculations of the magnetoelectric effect in a disordered two-dimensional CuO₂ loop current model for different types of disorder.

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Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

High Energy Physics & Cosmology II (Chair: Eugen Radu, UA) / 181

Electromagnetic Duality in Black Hole Mergers

Authors: Bozzola^{None}; Carlos Herdeiro^{None}; José Ferreira¹; Miguel Zilhão^{None}; Paschalidis^{None}

¹ *University of Aveiro*

The electromagnetic duality is a symmetry of Maxwell's equations in vacuum that can be used as a method to generate dyonic or magnetic solutions from the purely charged case. Since this symmetry does not make any assumptions regarding the underlying geometry, it also applies to dynamical spacetimes. Here, we show that the emitted electromagnetic radiation differs between solutions in the same dual family and explore this duality in dynamical spacetimes.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

High Energy Physics & Cosmology II (Chair: Eugen Radu, UA) / 182

EEEC from CFT correlation functions

Author: Ricardo Almeida Rodrigues¹

Co-authors: Carlos Bercini ; Eduardo Silva ; João Vilas Boas ; Sebastian Harris ; Vasco Gonçalves

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We extend event shape distributions for N detectors in conformal field theories. We explain how to compute this observable starting from the Euclidean kinematic by means of a non-trivial analytic continuation which can be elegantly performed in Mellin space. We study the formalism in detail for three scalar detectors in N=4 SYM both at weak and strong coupling and we also consider a mixed of scalar and energy detectors.

Which topic best fits your talk?:

High Energy Physics and Particles

Affiliations:

Condensed Matter Physics and Nanomaterials III (Chair: TBD) / 184

Phase Transitions and Uniaxial Negative thermal Expansion in CsNdNb₂O₇: Combined Local Probe and Diffraction Study

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Co-authors: António Cesário²; Armandina Lopes²; Estelina Silva²; Helena Petrilli³; João Araújo²; João Correia⁴; Lucy Assali³; Neenu Lekshmi²; Pedro Rocha Rodrigues²

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Zhu et al. [1] report that the CsNdNb₂O₇ system undergoes two phase transitions: a polar-to-antipolar structural change at 625 K followed by a transition to the aristotype at 800 K, resulting in three distinct phases—P2₁am (#26), C2/m (#12), and P4/mmm (#123). Their study attributes these transitions to rotations and tilts of NbO₆ octahedra, which not only stabilize the polar ferroelectric phase but also induce negative thermal expansion (NTE) in the c-axis lattice parameter during the 625 K transition.

Building on these findings, our work employs a multimodal strategy to systematically investigate the phase behavior and structural evolution of CsNdNb₂O₇. Synchrotron X-ray diffraction (SXRD) provides high-precision measurements of lattice parameters and confirms the occurrence of NTE [1]. However, due to SXRD's limited sensitivity to light elements and subtle local distortions, we incorporate three complementary techniques:

- Perturbed Angular Correlation (PAC) Spectroscopy: A local probe is highly sensitive to atomic-scale dynamics, measuring the electric field gradient (EFG) at specific sites to capture information on local symmetry and NbO₆ rotational environments.
- Neutron Powder Diffraction (NPD): Leveraging the large neutron scattering cross-section of oxygen, NPD accurately determines oxygen positions, enabling detailed quantification of temperature-dependent distortions in both the perovskite and rock-salt layers, which are directly linked to the NTE mechanism.
- Density Functional Theory (DFT): Utilizing structural data from NPD, DFT calculations provide theoretical EFG values and offer an in-depth analysis of the electronic and structural intricacies underlying the phase transitions.

By integrating local (PAC), long-range and oxygen-sensitive (NPD), and theoretical (DFT) methodologies, our approach delivers critical new insights into the underlying mechanism of negative thermal expansion (NTE).

Our findings not only confirm the previously proposed structural evolution in CsNdNb₂O₇ but also underscore the importance of a multimodal characterization strategy in understanding phase transitions and thermal expansion anomalies in layered perovskites, particularly within the Dion-Jacobson family.

[1] Zhu T., et al., Chemistry of Materials 32, 10, 4340–4346 (2020).

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

University of Porto; IFIMUP

Optics & Photonics (Chair: Michael Belsley, UM) / 185

Mapping the Funnel of Life: Luminescent Nanoprobes as Reporters of Hydration-Water Structural Heterogeneity

Author: Ramon Raposo Filho¹

Co-authors: Carlos D.S. Brites²; Luís D. Carlos²

¹ *University of Aveiro*² *CICECO - University of Aveiro*

Water's anomalies stem from fluctuations between low-density (LD) and high-density (HD) local structural motifs, which remain difficult to probe within the hydration layers governing biomolecular and colloidal stability. We demonstrate that luminescent nanoprobe, including upconversion nanoparticles (UCNPs), CdTe quantum dots (QDs), and fluorescent proteins, act as reporters of this structural polymorphism. By monitoring temperature-dependent optical and Brownian observables, we identify a characteristic crossover temperature (T_c) marking the depletion of LD motifs [1].

Our findings establish effective surface charge density (σ_f) as a unifying descriptor for T_c : higher interfacial electrostatics stabilize LD motifs, causing data from diverse systems to collapse onto a single master curve [2]. This framework is validated through isotopic substitution (D₂O and H₂18O), which perturbs hydrogen-bond dynamics and shifts these structural crossovers [3]. Extending this to high-pressure regimes using diamond anvil cells, we report the first evidence of pressure-induced LD fluctuation suppression. Above 0.1 GPa, the bilinear optical signature of CdTe QDs vanishes, resulting in a strictly linear response. This collapse of structural heterogeneity provides direct support for the "Funnel of Life" scenario, identifying a pressure-dependent boundary for water's anomalies [4]. Together, these results establish luminescent nanoprobe as a powerful toolset for navigating water's complex metastable landscape.

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Which topic best fits your talk?:

Optics and Photonics

Affiliations:

CICECO - University of Aveiro

High Energy Physics and Cosmology I (Chair: Ricardo Z. Ferreira, UM) / 186

A Parameter Scan of Current-Carrying Cosmic Strings

Author: Ricarda Heilemann¹

Co-authors: Carlos Martins ²; José Ricardo Correia

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Cosmic string networks are expected to form during symmetry-breaking phase transitions in the early Universe via the Kibble mechanism and arise naturally in many extensions of the Standard Model. In several such scenarios, string networks can carry additional degrees of freedom, such as charges and currents, leading to so-called current-carrying or superconducting cosmic strings. These additional degrees of freedom can significantly affect the evolution of the networks and may lead to distinctive observational signatures. In this work we study the evolution of current-carrying cosmic string networks using large-scale field theory simulations of a $U(1) \times U(1)$ model containing two complex scalar fields and their associated gauge fields. In the parameter regime considered here, one sector undergoes symmetry breaking and forms cosmic strings, while the second scalar field remains unbroken outside the string core and provides a condensate localized on the string worldsheet. We explore the network evolution across a broad region of the model's parameter space, varying condensate and coupling parameters while maintaining the conditions required for stable

current-carrying solutions. If time permits, we also present a first characterization of the power spectra of the charge and current fields, providing new numerical diagnostics for the dominant energy loss mechanism of these networks.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

Centro de Astrofísica da Universidade do Porto

Condensed Matter Physics and Nanomaterials I (Chairs: Bernardo Almeida and Clarisse Ribeiro, UM) / 188

Development of a Digital Fast-Timing γ Spectrometer

Author: Antonio Duarte Neves Cesario¹

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In recent years, nuclear spectroscopy experiments have progressively replaced traditional analog setups with compact and affordable digital data acquisition systems. These systems reduce size and electronic complexity while maintaining adequate performance for a wide range of applications.

More recently, digital Time Differential Perturbed Angular Correlation (PAC) spectroscopy setups have been implemented at ISOLDE/CERN and at IFIMUP (Porto, Portugal) using CAEN DT5730s digitizers operating at a sampling rate of 500 MS/s with 14-bit ADC resolution. For PAC experiments employing probes such as ^{111m}Cd and ^{111}In , whose probe state has a half-life of 84 ns, the digital systems are fully operational and provide results equivalent to those obtained with conventional analog electronics.

However, PAC studies using probes with much shorter probing half-lives, such as ^{199m}Hg (2.46 ns) and ^{181}Hf (10.8 ns), remain limited. These experiments require an effective time stamp resolution significantly smaller than the digitizer sampling period of 2 ns, which cannot be achieved through hardware-based digital processing alone. This limitation can nevertheless be addressed through post-processing of the detector output signals, taking advantage of the high 14-bit ADC resolution.

In this work, the recorded waveforms were subjected to several off-line timing methods to refine the determination of event timestamps. Results obtained from 511-511 keV photon coincidences following the β^+ decay of ^{22}Na show a clear improvement in time-stamping resolution. The method becomes effectively insensitive to sub-2 ns delays between the arrival times of the two photons. These results indicate that cost-effective digitizer units can be employed in modern detection experiments while preserving good timing performance and eliminating the need for precise channel synchronization.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Faculdade de Ciências da Universidade do Porto

Condensed Matter Physics and Nanomaterials I (Chairs: Bernardo Almeida and Clarisse Ribeiro, UM) / 189

COMPOSITE SCINTILLATING NANOFIBERS BY ELECTROSPINNING FOR RADIATION DETECTION

Author: Áureo Ucuajongo¹

¹ *Center of Physics of the Universities of Minho and Porto (CF-UM-UP), Laboratory for Materials and Emergent Technologies (LAPMET), Universidade do Minho, Braga, Portugal*

Scintillation is the phenomenon of luminescence in solids, liquids or gases, originating at the propagation of the ionizing radiation through them. It has long found applications in radiation detection and dosimetry. Currently, most commercial scintillators are inorganic compounds. They exhibit excellent scintillation properties, but suffer from harsh fabrication conditions, high costs and sensitivity to humidity and oxygen. Organic scintillators have also attracted significant attention as they have abundant source materials, ease of processing, low cost and mechanical flexibility. However, they usually give less light output and have weaker interaction with X-rays and gamma rays than inorganic scintillators, so they can be less efficient for high-energy photon detection. Thus, in order to improve these aspects, here we report the creation of hybrid composite nanofibers, combining strong scintillator nanoparticles (anthracene: C₁₄H₁₀) and BaF₂ incorporated into a polymer matrix of PET (polyethylene terephthalate), produced by electrospinning. The aim is to combine the strong scintillation response of the organic and inorganic phase with the sustainability, biocompatibility and mechanical flexibility of the host polymer. Their structural, chemical, mechanical, dielectric and optical properties were characterized.

The results show that the nanofibers have a homogeneous surface morphology, and average diameters around 734nm for C₁₄H₁₀ and 1371,9 nm for BaF₂. The successful inclusion of the C₁₄H₁₀ and BaF₂ particles inside the fibers was observed by X-ray diffraction, Raman spectroscopy, and Infrared spectroscopy. The optical and luminescent properties show absorption peaks from 293nm to 375nm, and emission from 379nm to 479nm with respect to the anthracene. The diffuse reflectance results show that the composite nanofibers exhibit two different transitions resulting from PET and C₁₄H₁₀ contribution, with band gap estimated at PET = 3.86 eV and C₁₄H₁₀ = 2.86 eV respectively. The further influence of the anthracene and BaF₂ on the fiber's properties will be presented.

Key words: Nanofibers, scintillators, electrospinning, radiation detection

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

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Optics & Photonics (Chair: Michael Belsley, UM) / 190

Post-processing micro/nanotechnologies of fiber tip sensors

Author: João Santos¹

Co-authors: Jeroen Missinne²; Joerg Bierlich³; Marta Ferreira¹; Micael Nascimento¹

¹ *Universidade de Aveiro*

² *Ghent University*

³ *Leibniz Institute of Photonic Technology*

The interfacing of optical fibers with materials can lead to greater versatility for measurand detection. In this work, we fabricated microstructures at a fiber tip, using different fibers, for sensing. One method is the self-written waveguide, which was developed in single mode and hollow core fibers, attaining Fabry-Perot interferometers for temperature and humidity sensing. Another method is the two-photon polymerization, which was also used in different fibers to fabricate more complex structures at the fiber tips, allowing for interferometers to arise while providing open access channels to the hollow core fibers. These configurations were also used for simultaneous detection of temperature and humidity with high resolution.

Which topic best fits your talk?:

Optics and Photonics

Affiliations:

University of Aveiro

High Energy Physics and Cosmology I (Chair: Ricardo Z. Ferreira, UM) / 191

Symmetry Aware Ansatz for Matrix Quantum Mechanics

Author: Júlio Oliveira¹

¹ *University of Porto*

We develop a symmetry-aware neural quantum state for the $SU(2)$ minimal BMN model. The ansatz enforces gauge and $SO(2)$ invariance through a trace-operator basis and incorporates a WKB-inspired asymptotic tail. This construction enables us to probe the model deep into the strong-coupling regime.

Which topic best fits your talk?:

High Energy Physics and Particles

Affiliations:

CFP

Condensed Matter Physics and Nanomaterials II (Chair: André Chaves, UM) / 192

Linear-Scaling Estimation of Local Observable Maps

Author: Henrique Veiga¹

¹ *Centro de Física das Universidades do Porto e Minho; University of York*

In condensed matter systems where translational invariance is inevitably or deliberately broken, probing local observables is paramount to addressing a wealth of intriguing phenomena, such as multifractality, quasiparticle interference and real-space orbital magnetic textures.

In this talk we show that the well-known computational bottleneck of computing local properties in non-periodic lattices of realistic sizes can be circumvented by the use of a novel, highly scalable real-space approach [1]. After demonstrating its significant advantages by benchmarking on the π -flux model with isolated and clustered defects, we extend our numerical framework to inhomogeneous

correlated systems [2]. As a proof of concept, the method is used to investigate the local robustness of s-wave and p-wave superconducting phases in disordered graphene in a fully non-perturbative fashion. These results bring opportunities for the real-space simulation of non-periodic quantum phases of matter beyond previous approaches.

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Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

CF-UM-UP, Universidade de York

Condensed Matter Physics and Nanomaterials I (Chairs: Bernardo Almeida and Clarisse Ribeiro, UM) / 193

Local magnetic fields in NdFeO₃ from μ SR and first-principles non-collinear calculations

Author: Muhammad Aasim¹

¹ *PhD Physics Student at IFIMUP - Faculty of Science of the University of Porto*

INTRODUCTION

Rare-earth orthoferrites, such as NdFeO₃, exhibit intricate magnetic and structural transitions, making them compelling for spintronics and optoelectronic applications. NdFeO₃ undergoes a spin-reorientation transition (SRT) between 170 K and 100

K, accompanied by symmetry changes from orthorhombic (Pbnm) to monoclinic (P2₁/c). This work explores these

phenomena and their implications, leveraging both experimental data (1-3) and first-principles calculations. The inclusion of

hydrogen impurities and their behavior further adds novelty, offering insights into local environments and structural

transitions relevant to muon spin spectroscopy.

EXPERIMENTAL / THEORETICAL STUDY

The research combines experimental techniques, including Resonance Ultrasound Spectroscopy (RUS) and muon

spectroscopy measurements, with computational approaches using Density Functional Theory (DFT) implemented in VASP.

Simulations incorporate Generalized Gradient Approximation (GGA), PBE+U, Hubbard U corrections, and spin-orbit

coupling to examine the magnetoelastic properties, and hydrogen (H) impurity effects.

RESULTS AND DISCUSSION

Experimental results reveal a structural phase transition that occurs during SRT, with monoclinic symmetry emerging below

170 K and disappearing by 105 K (4). This transition aligns with the observed elastic constant softening (related to the

acoustic frequency softening at the zone-boundary) and spin reorientation of the Fe magnetic states from the c-axis to the a-

axis. Computational studies will corroborate these findings, elucidating the role of hydrogen impurities in modifying elastic

properties during SRT. Preliminary simulations by including the H impurity will support muon spectroscopy observations,

where evidences of a structural phase transition can definitely now be established.

CONCLUSION

This study bridges experimental observations and theoretical predictions, elucidating the SRT and structural phase transitions in NdFeO₃. By incorporating H impurities and analyzing the magnetoelastic coupling, this work advances the understanding of rare-earth orthoferrites' properties. Future research will focus on high-pressure behaviors for potential spintronic applications.

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(CINECA)

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

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High Energy Physics & Cosmology II (Chair: Eugen Radu, UA) / 194

A Freeze-In Interpretation of the LZ 248 keV Nuclear Recoil Event

Author: Vinícius Oliveira¹

¹ *Universidade de Aveiro*

The LUX-ZEPLIN (LZ) experiment recently reported a nuclear recoil candidate at $E_R \simeq 248$ keV. Inelastic dark matter (DM) is among the best-motivated explanations of this signal, since it suppresses the low-energy recoils that elastic scattering would predict. However, in thermal freeze-out the relic density fixes the DM–nucleon cross section for a given mass. In this talk, based on arXiv:2609.13130, we will consider a pseudo-Dirac fermion with a heavy Z' mediator, produced via freeze-in with a reheating temperature T_R below the DM mass. We will show that T_R breaks the one-to-one relation between mass and cross section. As a result, the LZ candidate is reproduced over a continuous region of parameter space, including splittings below the thermal benchmark, with m_χ 0.5–1 TeV as the most favourable range.

Which topic best fits your talk?:

High Energy Physics and Particles

Affiliations:

University of Aveiro

Condensed Matter Physics and Nanomaterials II (Chair: André Chaves, UM) / 195

Tensor network approach to real-space superconductivity in quasicrystals

Authors: Ricardo Oliveira¹; Bruno Amorim²; Eduardo Castro³

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The recent discovery of superconductivity in quasiperiodic twisted trilayer graphene (tTLG) underscores the complex interplay between quasiperiodicity and interactions in moiré materials [1]. Furthermore, previous work by the authors [2] has shown that quasiperiodicity can lead to an enhancement of superconductivity in one-dimensional quasiperiodic models. However, a proper theoretical description of superconductivity in quasiperiodic moiré materials is still lacking, due to the lack of translational invariance that implies that real-space numerical methods must be necessarily employed to study moiré systems such as twisted bilayer graphene (tBLG), requiring the simulation of system sizes in the order of millions of atoms [3].

We propose a real-space tensor network approach to study s-wave superconductivity in two-dimensional quasicrystals with eightfold rotational symmetry. Building on the tensor network kernel polynomial method combined with the quantics tensor cross interpolation method (QTCI) to represent ultra-large real-space Hamiltonians [4, 5], we can obtain real-space mean-field solutions for on-site pairing across systems exceeding one billion sites. This scalable approach enables computation of the local density of states and the spatially resolved superconducting pairing, revealing how eightfold symmetry and the quasiperiodic structure of the system shapes the texture of s-wave order. Our work opens a path towards quantitative real-space characterization of superconductivity in quasiperiodic moiré systems that require large-scale simulations.

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Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Condensed Matter Physics and Nanomaterials III (Chair: TBD) / 196

Charge transport and optical surface state signatures of disordered topological insulator systems

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The integration of 3D topological insulator (TI) materials, such as Bi₂Te₃, Bi₂Se₃, and Sb₂Te₃, into emerging technological platforms has attracted significant research interest across various fields,

particularly in spintronics [1]. While their fundamental properties have been extensively studied in crystalline systems, particularly epitaxial films, disorder, finite-size effects, and interfaces can introduce complex parallel conduction pathways that complicate the identification of transport phenomena associated uniquely with the topological surface states (TSS) [2]. This is particularly relevant in disordered systems where direct band-structure probes, such as angle-resolved photoemission spectroscopy (ARPES), become experimentally unfeasible, motivating correlative approaches that combine electronic transport with complementary probes.

In this work, we first investigate the structural and electronic properties of disordered Bi_2Te_3 thin films (13–191 nm) produced through sputtering deposition on flexible, polyimide substrates [3]. Raman spectroscopy, X-ray diffraction, and electron microscopy reveal polycrystalline, granular films whose structural organization is substantially improved following ex-situ annealing at $T_a > 250$ °C. Temperature-dependent resistivity measurements of annealed films ($T_a = 300$ °C) reveal a meta-metallic transport regime (20 - 100 K), consistent with previous reports on granular films and with competition between bulk (semiconducting) and surface (metallic) conduction contributions. Isothermal magnetoconductance measurements (3 – 20 K) show characteristic weak antilocalization (WAL). Analysis via the Hikami–Larkin–Nagaoka model reveals a monotonic increase of the pre-factor α with thickness ($0.5 \rightarrow 1$), consistent with the expected thickness-dependent coupling of TSS channels [4]. Concurrently, the decoherence exponent of the phase coherence length ($L_\phi \propto T^{-p}$) shifts from $0.7 \rightarrow 0.5$ post-annealing, indicating a shift towards 2D-dominated quantum coherence effects.

Motivated by the growing interest in printed and solution-processable functional 2D and quantum materials, we extend this study to hybrid TI/polymer composites prepared from solvothermally synthesized nano-pellets of Bi_2Te_3 embedded in a polymeric matrix, aiming to investigate whether similar transport signatures can persist in such systems. The disordered composite network exhibits temperature-dependent transport consistent with Efros–Shklovskii variable range hopping, while magnetoconductance measurements reveal strongly suppressed 2D WAL contributions within the HLN description ($\alpha \sim 0.001$, $L_\phi \propto T^{-0.5}$).

As a complementary approach for probing surface-state dynamics, we have developed an optical pump–probe setup which uses a femtosecond laser operating at 800 nm. Preliminary measurements of epitaxial Bi_2Se_3 reference samples reveal system relaxation consistent with expected contributions from both electron–electron and electron–phonon relaxation processes.

These results highlight the crucial role of structural engineering in enabling robust surface transport and the importance of establishing consistent metrology for surface state signatures in disordered samples, demonstrating the potential of scalable, flexible TI-based platforms for beyond-CMOS applications.

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Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

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Condensed Matter Physics and Nanomaterials III (Chair: TBD) / 197

Electrospun Nanofibers for Advanced Solar Cells

Authors: Bernardo Almeida^{None}; sameh ifa^{None}

This thesis project focuses on the development of functionalized, photoactive hybrid nanofibers for potential application in next-generation photovoltaic technologies. The research investigates the incorporation of photoactive organic materials, particularly MDMO-PPV:PCBM, and natural pigments such as chlorophyll and curcumin into biopolymer matrices to produce composite nanofibers by electrospinning.

The experimental work involves the preparation of polymeric solutions containing the selected photoactive materials, followed by electrospinning to obtain functionalized nanofiber mats. The influence of the preparation and electrospinning conditions on the resulting fiber morphology is being investigated. Particular attention is given to chlorophyll as a naturally derived photoactive material, while a second photoactive material is currently under development and characterization.

The morphology of the developed nanofibers is being evaluated by scanning electron microscopy (SEM). The experimental preparation process and the current SEM characterization will be discussed as part of the ongoing research.

Overall, the project aims to contribute to the development of flexible, biocompatible, and potentially sustainable solar-active nanofiber mats with potential applications in flexible and wearable photovoltaic technologies.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Climate and Environment (Chair: Alfredo Rocha, UA) / 199

Tropical Cyclones in the Mozambique Channel: Present Variability, Climate Drivers and Implications for Early Warning Systems

Author: Isildo Gomes¹

Co-authors: Alfredo Rocha ¹; Ana Carvalho ²; David Carvalho ¹; Susana Vaz ¹

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Southern Africa is highly exposed to multiple climate extremes, including tropical cyclones (TCs), floods, droughts and heatwaves. In particular, TCs within the Mozambique Channel (MC) domain impose recurrent humanitarian and economic costs. Moreover, objective evaluations of automated TC screening algorithms in this region are still lacking. Hence, there is a clear need to develop, implement and evaluate these algorithms over this domain. This doctoral research investigates the present variability and future projections of these systems, with particular emphasis on TCs in the MC and their implications for Early Warning Systems.

This study validates the Cyclone TRACKing framework (CyTRACK) algorithm for detecting and tracking TCs within the MC from 1999–2025. ERA5 reanalysis data are used as input, and the results are evaluated against the International Best Track Archive for Climate Stewardship (IBTrACS) dataset as a reference. Spatial validation indicates high reliability, with a mean absolute error (MAE) of approximately 42 km, well within World Meteorological Organization operational thresholds. In addition, a total of 71 reference TCs were assessed and 49 TCs were detected and tracked, with a probability of detection (POD) of 69%, and a false alarm ratio (FAR) of 0%. Therefore, this validated framework provides the basis for regional cyclone climatology and variability analysis, particularly future projections.

The research assesses regional climatology, large-scale climate signals and thermodynamics, exhibiting a pronounced seasonal TCs concentration between January and March. In the 2020s, rapid intensification (RI) events increased by 43.8 per cent, whilst landfall systems activity rose 43.5% yearly. Geographical tracking reveals that the central coast of Mozambique accounts for approximately 46.2 per cent of all historically recorded landfalls. Finally, a diagnostic framework using products relating

to sea surface temperature (SST), Relative Oceanic Niño Index (RONI), Indian Ocean Dipole (IOD) indices, and compound-scenario analyses demonstrate that interacting ocean/atmospheric conditions substantially alter cyclone metrics (genesis, landfall, severity, RI, and energy dissipation), supported by robust statistical diagnostics.

Which topic best fits your talk?:

Climate and Environment

Affiliations:

Condensed Matter Physics and Nanomaterials I (Chairs: Bernardo Almeida and Clarisse Ribeiro, UM) / 200

Cyclodipeptides based composite electrospun nanofibers for Energy Harvesting Applications

Author: Daniela Santos¹

¹ *University of Minho - CFUM and INL*

The production of functional materials derived from dipeptides is gaining significant attention in biotechnology due to their biocompatibility, structural rigidity, versatile morphologies, and ease of functionalization and synthesis. Cyclodipeptides are an emerging group of ring-shaped dipeptides, that exhibit the unique ability to dimerize into quantum dots which self-assemble into supramolecular structures with different morphologies (nanospheres, nanotubes, nanowires, nanofibers) showing quantum confinement and photoluminescence. Amino acids, the building blocks of dipeptides, exhibit chirality. Their non-centrosymmetric structure enables spontaneous polarization and/or ferroelectricity, which is the basis of piezoelectric and pyroelectric effects with applications in optoelectronics and beyond. As a result, cyclodipeptides hold great potential for applications in biological tissue imaging and piezoelectric microdevices.

Electrospinning is a widely used technique for creating nano- or microfibers by utilizing an electric field to draw and elongate a polymer solution into ultrafine fibers. This method also facilitates the functionalization of polymer matrices with active materials to achieve desired properties. As cyclodipeptides exhibit high thermal stability and mechanical strength, in our work, we utilized these properties to make nanofiber systems incorporating dipeptides into PA-11 nanofibers. In this respect, nylon 11 or polyamide 11 (PA-11), a semi-crystalline high-performance polymer has attracted significant attention due to its high sustainability, which is produced from renewable resources. They also exhibit pyroelectric and piezoelectric properties. These characteristics make it an ideal material for use in combinations with the cyclodipeptides, to produce composite nanofibers for piezoelectric energy harvesters, sensors, and nanogenerators.

The obtained nanofibers containing self-assembled nanostructures embedded into the polymer matrix, are wide-band gap semiconductors with 4.0 eV bandgap energy. We studied their structural, morphological, optical, piezoelectric and pyroelectric responses, towards hybrid systems for energy generation and built a prototype energy harvesting system.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

CFUM/INL

High Energy Physics & Cosmology II (Chair: Eugen Radu, UA) / 201

EMRI dynamics around rotating boson stars

Authors: Carlos Herdeiro¹; Manuel Mariano¹

¹ *Universidade de Aveiro*

Extreme mass-ratio inspirals (EMRIs) are expected to provide precision probes of strong field gravity and the nature of compact objects, making them key targets for LISA. While Kerr black holes remain the standard paradigm, exotic compact objects such as rotating boson stars have emerged as possible alternatives. These horizonless objects can have a toroidal energy distribution, leading to a richer geodesic structure and novel orbital features absent in Kerr spacetimes. In this work, we study the evolution of equatorial EMRIs around rotating boson stars under the adiabatic approximation. In the quasi-circular limit, we showed that an inspiral can be naturally followed by an outspiral phase, producing a backward chirp in the gravitational-wave signal. We further derive the conditions under which such behaviour can arise in generic compact objects. Finally, we also extend the analysis to eccentric orbits.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

Universidade de Aveiro

High Energy Physics & Cosmology III (Chair: Raul Sarmiento, UM) / 202

VIGILant: an automatic classification pipeline for glitches in the Virgo detector

Author: Tiago Fernandes^{None}

Glitches frequently contaminate data in gravitational-wave detectors, complicating the observation and analysis of astrophysical signals. This work introduces VIGILant, an automatic pipeline for classification and visualization of glitches in the Virgo detector. Using a curated dataset of Virgo O3b glitches, two machine learning approaches are evaluated: tree-based models (Decision Tree, Random Forest and XGBoost) using structured Omicron parameters, and Convolutional Neural Networks (ResNet) trained on spectrogram images.

While tree-based models offer higher interpretability and fast training, the ResNet34 model achieved superior performance, reaching a F1 score of 0.9772 and accuracy of 0.9833 in the testing set, with inference times of tens of milliseconds per glitch. The pipeline has been deployed for daily operation at the Virgo site since observing run O4c, providing the Virgo collaboration with an interactive dashboard to monitor glitch populations and detector behavior. The pipeline also identifies low-confidence predictions, highlighting glitches requiring further attention.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

Optics & Photonics (Chair: Michael Belsley, UM) / 203

Harnessing photons for quantum information processing - from Interaction-free Quantum Imaging to Photonic Quantum Computing

Author: Sara Franco¹

Co-authors: Anita Camillini²; Ernesto F Galvao³

¹ *Universidade do Minho/INL*

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³ *Instituto de Física, Universidade Federal Fluminense*

The use of quantum mechanical systems for the storing, processing and transmission of information unlocks potential gains in speed and functionality inaccessible to classical technologies.

Photonic platforms in particular are powerful sensing technologies, and their quantum behaviour can be exploited for the highly non-classical imaging technique of interaction-free imaging. In principle, this protocol allows the imaging of an object with much less than the classically expected amount of light being absorbed or scattered by the object, useful, for instance, to image photosensitive biological samples or ultracold atom clouds. In the first part of this talk, we will explore an extension of the standard scheme to the imaging of multiple objects with a single quantum probe and discuss its experimental implementation on a universal integrated photonic processor.

Photonic-based systems are also a promising candidate for building general-purpose quantum computers, which promise to bring exponential speed-ups in certain algorithms currently unattainable to the most powerful classical supercomputers. One relevant architecture, called Spin-Optical Quantum Computing (SPOQC), combines spin-based single photon emitters with photonic flying qubits, benefitting from the best features of both light and matter systems. In the second part of the talk, we explore a SPOQC implementation of a protocol for the preparation of magic states, a key resource for the universality of quantum computers which is non-trivial and typically expensive to prepare. We discuss how this protocol significantly lowers demands on required resources at the cost of robustness to noise, and how it may be more adequate for near-term, lower-scale devices.

Which topic best fits your talk?:

Optics and Photonics

Affiliations:

Universidade do Minho, International Iberian Nanotechnology Laboratory

High Energy Physics & Cosmology III (Chair: Raul Sarmiento, UM) / 204

Machine Learning Anomaly Detection techniques for the search of new physics at LHC with ATLAS experiment

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² *LIP (Laboratório de Instrumentação e Física Experimental de Partículas)*

³ *LIP and University of Minho*

Anomaly Detection (AD) has recently emerged as a promising approach to the analysis of data collected at the Large Hadron Collider (LHC) in the search for phenomena beyond the Standard Model (SM) of particle physics. AD methods rely on the use of machine learning techniques to learn the characteristics of well-understood Standard Model processes and identify events that exhibit significant deviations from the expected background behavior.

A key advantage of anomaly detection over conventional, model-driven searches at the LHC is its reduced dependence on specific signal hypotheses. Rather than targeting a particular New Physics (NP) process predicted by a given theoretical model, AD aims to identify a broad class of events

that are inconsistent with the Standard Model expectation. This model-agnostic character provides a complementary strategy for exploring the vast and largely unconstrained space of possible extensions of the Standard Model.

Such an approach is particularly relevant in the context of several open questions in particle physics, including the nature of dark matter, the origin of the matter–antimatter asymmetry, and the hierarchy problem. By providing sensitivity to unexpected signatures that may not be captured by existing targeted searches, anomaly detection has the potential to broaden the scope of the experimental programme at the LHC.

The work presented in this thesis contributes to this effort by developing and investigating anomaly detection techniques for two distinct applications within the ATLAS experiment. The first concerns the search for New Physics in events characterised by high-transverse-momentum jets and large missing transverse momentum, commonly referred to as the “mono-jet” signature. The second application focuses on the assessment of data quality in the ATLAS Hadronic Tile Calorimeter. These two studies illustrate the versatility of anomaly detection, demonstrating its potential both as a tool for discovering unexpected physics signatures and as a means of identifying anomalous detector behaviour.

Which topic best fits your talk?:

High Energy Physics and Particles

Affiliations:

Laboratory of Instrumentation and Experimental Particle Physics (PT)

Condensed Matter Physics and Nanomaterials III (Chair: TBD) / 205

Lead-free multiferroic heterostructures for enhanced magnetic field sensing

Authors: João Araújo¹; Tiago Rodrigues²

Co-authors: Bernardo Almeida³; José da Silva³

¹ IFIMUP

² University of Minho

³ CFUM

Nanostructured strain-coupled multiferroic composite thin films, combining magnetostrictive and piezoelectric phases, have attracted wide interest due to their strong magnetoelectric (ME) effect. Their stress-mediated coupling arises from the interfacial mechanical interaction between the two phases, which links their elastic, electric and magnetic fields and enables the mutual detection and control of magnetic and electric signals. Single-phase magnetoelectrics remain impractical for most devices, as their ordering temperatures lie below room temperature, whereas composite systems offer larger ME responses and a far wider choice of active phases. Applications span information storage, actuators, antennas and lower power electronics, and, importantly, magnetic field sensing. However, the dynamical magnetic-electric properties of nanoscopic bilayer systems and their application in magnetic field sensing remains poorly explored.

Pulsed laser deposition allows epitaxial oxide heterostructures to be grown with nanometric thickness control and was used in this work to prepare lead-free bilayer nanocomposite films combining BCZT ((1-x)(Ba_{0.7}Ca_{0.3})TiO₃-x[Ba(Zr_{0.2}Ti_{0.8})O₃]) and CoFe₂O₄ on SrTiO₃ (100) substrates. BCZT is a ferroelectric with a piezoelectric coefficient reaching 496 pC/N in bulk ceramic samples, comparable to state-of-the-art PZT ceramics, while CoFe₂O₄ is an inverse spinel ferrite with high magnetostriction and magnetocrystalline anisotropy, making them good candidates for strain-mediated ME coupling. Both stacking orders were grown, with either the ferroelectric or the ferrite deposited first, so that the influence of the growth sequence on the interface could be isolated.

The structural, morphological, dielectric and ferroelectric properties of the bilayers were characterized. X-ray diffraction shows that BCZT grows epitaxially on SrTiO₃ but becomes polycrystalline when deposited onto CoFe₂O₄. The two stacking orders sustain interfacial strain of opposite sign, tensile when BCZT is grown onto the STO substrate and compressive when deposited on CFO respectively. Impedance spectroscopy resolves two thermally activated relaxation processes together with a pronounced thermal hysteresis, while P–E measurements confirm the polar responses. Electrical behaviour depends strongly on the stacking order. The films with BCZT deposited first show much higher capacitance and well defined P-Hysteresis loops, as compared to the reverse configuration. This points to an important role of interfacial strain engineering in controlling the electrostatic boundary conditions in the multiferroic thin films.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

University of Minho

High Energy Physics and Cosmology I (Chair: Ricardo Z. Ferreira, UM) / 206

Parameter estimation of rotational core-collapse supernovae gravitational waves with deep learning

Author: Solange Nunes^{None}

Core-collapse supernova (CCSN) events remain one of the most compelling yet still uncovered sources of gravitational wave (GW) signals. Their detection would open a direct window into the physics unfolding deep within a collapsing stellar core. In this work, we evaluate deep-learning (DL) approaches for analyzing GW signals from rotating CCSN, addressing both the classification of these signals in detector noise and parameter estimation of three key bounce-signal parameters: the maximum (peak) frequency, (f_{peak}) , the GW strain amplitude (Δh) scaled by luminosity distance (D) , $(D \cdot \Delta h)$, and the rotation of the core. Training data are constructed from a set of numerically simulated CCSN waveforms, which we inject into real detector noise drawn from the second part of the fourth observing run (O4b) of the Advanced LIGO and Advanced Virgo instruments. Our classification network reliably distinguishes Galactic CCSN signals from noise once the signal-to-noise ratio (SNR) of the network exceeds 8, achieving an overall accuracy of 0.99. For parameter estimation, we find that all three parameters achieve an R^2 above 0.85, with the rotation rate achieving the best results ($R^2 = 0.91$). These results demonstrate that DL techniques offer a promising and computationally efficient approach for extracting physical information from a future Galactic CCSN GW detection.

Which topic best fits your talk?:

Astrophysics and Cosmology

Affiliations:

Centro de Física das Universidades do Minho e do Porto, Universidade de Valência

High Energy Physics and Cosmology I (Chair: Ricardo Z. Ferreira, UM) / 208

Dark transitions with a weak coupling

Climate and Environment (Chair: Alfredo Rocha, UA) / 209

Analysis of the aerosol atmospheric rivers affecting the Iberian Peninsula

Optics & Photonics (Chair: Michael Belsley, UM) / 210

III-V-on-Si Photosensitive NanoLED Arrays for an Insect Vision Inspired Neuromorphic On-Chip Platform

Climate and Environment (Chair: Alfredo Rocha, UA) / 211

Atmosphere-fire coupled wildfire modelling under climate change scenarios, using WRF-SFIRE.

Author: Ricardo Vaz^{None}

Co-authors: David Carvalho ; Paula Maia ¹; Susana Vaz ²

¹ *University of Aveiro*

² *Department of Physics & CESAM, University of Aveiro, Portugal*

Studying climate change impacts on wildfires has become key in recent decades, as climate linked extreme wildfire events have been occurring more often across southern Europe. Employing atmosphere-fire modelling frameworks that combine landscape characterization of fuels connected to atmospheric feedbacks, allows us to determine how certain weather conditions can affect a wildfire progression in a given location. In this study we employed the coupled atmosphere-fire numerical model WRF-SFIRE, in a phased approach to landscape management under future climate scenarios. The initial phase methodology used the Fire Weather Index (FWI) to determine high fire danger danger, assuming a worst-case scenario. This experiment used 13 fuel descriptors native to the United States, NFFL fuel models. In the current phase, the gap between NFFL and Portuguese fuel models was bridged, validating them across 4 different wildfires and comparing them to satellite based observations. Results provided improvements in burnt area and rate of spread estimates, less biased in the Portuguese fuel models. Simulated to satellite comparison estimates of fire energy release from fire showed an overestimation in both cases.

Which topic best fits your talk?:

Climate and Environment

Affiliations:

University of Aveiro, Department of Physics, CESAM

High Energy Physics & Cosmology II (Chair: Eugen Radu, UA) / 212

Effective Field Theory for Compact Objects in Holography

Condensed Matter Physics and Nanomaterials III (Chair: TBD) / 214**Signatures of Incommensurability in moiré Quasi- crystals****Author:** Raul Liquito¹**Co-authors:** Bruno Amorim ²; Eduardo Castro ³; Miguel Gonçalves ⁴; Nicolau Sobrosa¹ *Faculdade de Ciências Universidade do Porto*² *Faculdade de Ciências, Universidade do Porto*³ *CF-UM-UP, Faculdade de Ciências, Universidade do Porto*⁴ *Princeton Center for Theoretical Science, Princeton University*

Moiré materials represent one of the richest fields in condensed matter physics, with twisted bilayer graphene (TBG) serving as a prime example. TBG exhibits exotic physical properties, including unconventional superconductivity and delocalized eigenstates in both momentum and real space near the flat-band regime. Recent experiments on hBN/TBG and twisted trilayer graphene (TTG) have uncovered a new, intrinsically quasiperiodic regime driven by competing incommensurate moirés, dubbed moiré quasicrystals. Because these phases also host robust correlated states, understanding the exact role of quasiperiodicity is essential to determine whether such phenomena are driven by correlation, topology, or the explicit breaking of translational invariance.

To address this, we perform real-space atomistic tight-binding simulations of 2D moiré materials containing up to 15 million atoms. By comparing quasiperiodic and commensurate (unit cell = 1 moiré cell) TBG, we conduct a multifractal analysis of the local density of states to extract the singularity spectrum, a quantity directly accessible to experimentalists via STS maps. Our results show that incommensurate magic-angle TBG, the flat band is strictly multifractal, whereas commensurate structures remain monofractal.

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Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Universidade do Porto Faculdade de Ciências

Condensed Matter Physics and Nanomaterials II (Chair: André Chaves, UM) / 215**Quantics Purification Mean-Field Approach to 2D Moiré Materials****Author:** Nicolau Sobrosa^{None}**Co-authors:** Bruno Amorim ¹; Eduardo Castro ²; Jose Lado ³; Pedro Ribeiro ⁴; Tiago Antão ³; Yitao Sun ³¹ *Faculdade de Ciências, Universidade do Porto*² *CF-UM-UP, Faculdade de Ciências, Universidade do Porto*³ *Aalto University*⁴ *CeFEMA - IST*

The emergence of correlated phases, such as unconventional superconductivity, in two-dimensional moiré materials is one of the most fascinating developments in condensed matter physics. However, the interplay between the large-scale moiré patterns, the formation of flat bands, and the subsequent interaction-induced phases poses a significant challenge for

numerical simulations. In realistic settings, twist-angle disorder or substrate interactions are sufficient to break translation symmetry or create super-moiré effects precluding the use of standard continuum models.

To overcome this, we propose a mean-field approach enhanced by quantum tensor networks. By utilizing a tensor-train representation of the mean-field Hamiltonian and the reduced density matrix, this method achieves logarithmic scaling with the system size. This scaling is a crucial advantage, enabling the simulation of exponentially large systems and capturing super-moiré physics. By comparison, exact diagonalization or even linear scaling methods such as the Fermi Operator Expansion become prohibitive at this length scale.

In this work, we study a two-dimensional model hosting both flat bands and incommensurability-induced critical states. We introduce a zero-temperature purification scheme of the reduced density matrix that takes the tensor-network representation of the mean-field Hamiltonian and iteratively applies a low-order polynomial, converging to the density matrix. We analyze the real-space distribution of the charge density as well as its Fourier transform, to detect the presence of quasi-fractal order. Finally, we will discuss the physical implications of this quasi-fractal order for the broader understanding of strongly correlated phases in super-moiré systems.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

CF-UM-UP

Condensed Matter Physics and Nanomaterials I (Chairs: Bernardo Almeida and Clarisse Ribeiro, UM) / 216

Spatially and temporally modulated active patches for skin cancer treatment

Author: Diana Bogas¹

¹ *Centro de Física das Universidades do Minho e do Porto*

Skin cancer is the most common of all cancers and can be divided in three types: basal cell carcinoma, squamous cell carcinoma, and melanoma, the latter being the most aggressive. Current therapies for melanoma present several drawbacks, which highlights the need for new therapeutic approaches.

Electroactive, biocompatible, and biodegradable polymers, such as poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) and silk fibroin (SF), are attracting increasing interest for the development of active scaffolds in tissue engineering applications.

Nanotechnology applied to the healthcare area has demonstrated a significant impact in regenerative medicine and in conventional melanoma therapies. New alternative approaches to treat cancer are being based on nanotechnology and, among several alternatives, photodynamic effects based therapies have increased treatment efficacy.

In this study, fibers with different PHBV/SF ratios were produced by electrospinning. The materials were subjected to physicochemical and biological characterization. Their biological performance was evaluated using HaCat keratinocyte cells to mimic skin conditions. The effect of an active microenvironment was investigated by applying mechanical stimulation to induce an electrical response through the piezoelectric properties of fibers. Mechano-electrical stimulation appears to enhance keratinocyte proliferation. The antimicrobial activity of the developed materials was also evaluated against *E. coli* and *S. aureus* and preliminary results showed that the developed materials have antimicrobial properties against both strains.

In parallel, a study of nanoparticles was performed. Lab made and commercial samples were characterized regarding physical properties and photothermal behaviour. These nanoparticles showed different size, shape and light absorption. The different nanoparticles react to light and when included in the system add a new functionality.

In conclusion, this study shows promising materials and nanoparticles for the development of skin patches for regeneration and cancer treatment.

Which topic best fits your talk?:

Condensed Matter Physics and Nanomaterials

Affiliations:

Physics Centre of Minho and Porto Universities (CF-UM-UP)