PHD'S SEMINARS

Aula S4 every **Monday**

from **14:30** to **15:00**

2024-2025

List of Abstracts and talks

Dipartimento di Matematica e Fisica

Niccolò Tartaglia

Why attending the PhD's Seminars?

- Are you curious about the latest breakthroughs in physics and mathematics?
- Looking for guidance on selecting the perfect topic for your Master's or Bachelor's thesis?
- PhD Seminars is your key to explore cutting-edge research and finding the ideal path for your academic journey.

1. Explore Diverse Research Areas

PhD Seminars bring together the students of the UCSC International Doctoral Program in Science showcasing their research in areas spanning experimental and theoretical physics to mathematics.
Whatever your interest are, these seminars provide a chance to:

- Gain insights into real-world research challenges
- Taste various methodologies and approaches
- Discover innovative applications of physical and mathematical principles
- Connect with young researchers who can help you to determine if pursuing a PhD is right for you

2. Make Informed Choices for Your Thesis

Choosing a Master's or Bachelor's thesis topic may appear overwhelming, but it doesn't have to be! PhD Seminars provide a unique opportunity to connect with current UCSC PhD students and learn about their research firsthand. In an informal setting, you can engage with PhD students, ask questions about their work, explore the challenges they face, and discuss the future directions of their fields.

Experimental Physics **Theoretical Physics**

Mathematics **Data Science**

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Ultrafast Dynamics in cuprate superconductor Bi2212: a Green function approach

Francesco Proietto
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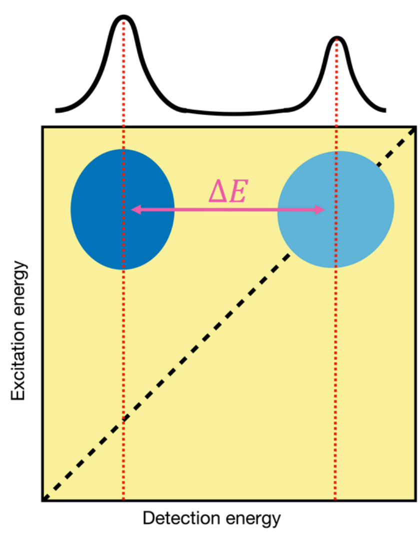
04 November 2024 14:30
Aula S4

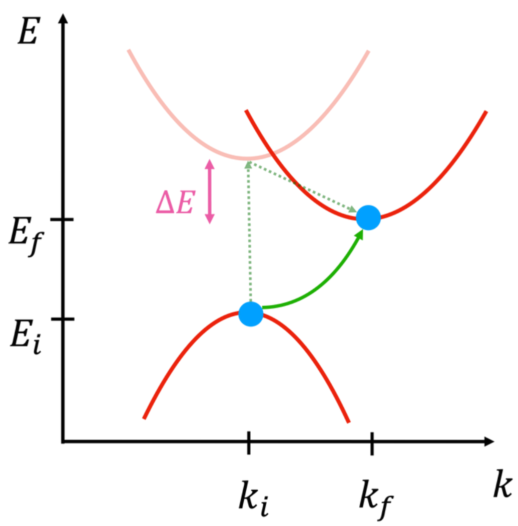
Supervisor: **Claudio Giannetti**

Cuprate superconductors are an ideal platform for investigating the mechanism responsible for the formation of the condensate and the high critical temperature in these non-conventional superconductors. These materials are known for their strong electronic interactions, where high-energy (~2 eV) excitations significantly impact low-energy (tens of meV) superconducting properties.

Here we present two-dimensional electronic spectroscopy (2DES) measurements on $Bi_2Sr_2Ca_{0.92}Y_{0.08}Cu_2O_{8+x}$ (Bi2212). 2DES is an advanced ultrafast spectroscopy technique that captures detailed information about how different energy levels interact on the timescale of tens of femtoseconds. Our results unveil a complex excitation pathway following infrared light absorption including charge-transfer excitation and coupling with magnetic excitation.

We employ the Green-functions formalism to describe the electronic and magnetic degrees of freedom, as well as the indirect transition process itself. The inelastic interaction with magnetic excitation is necessary to guarantee energy and momentum conservation.





MINTs based chemiresistor array for gas detection and identification

Michele Galvani
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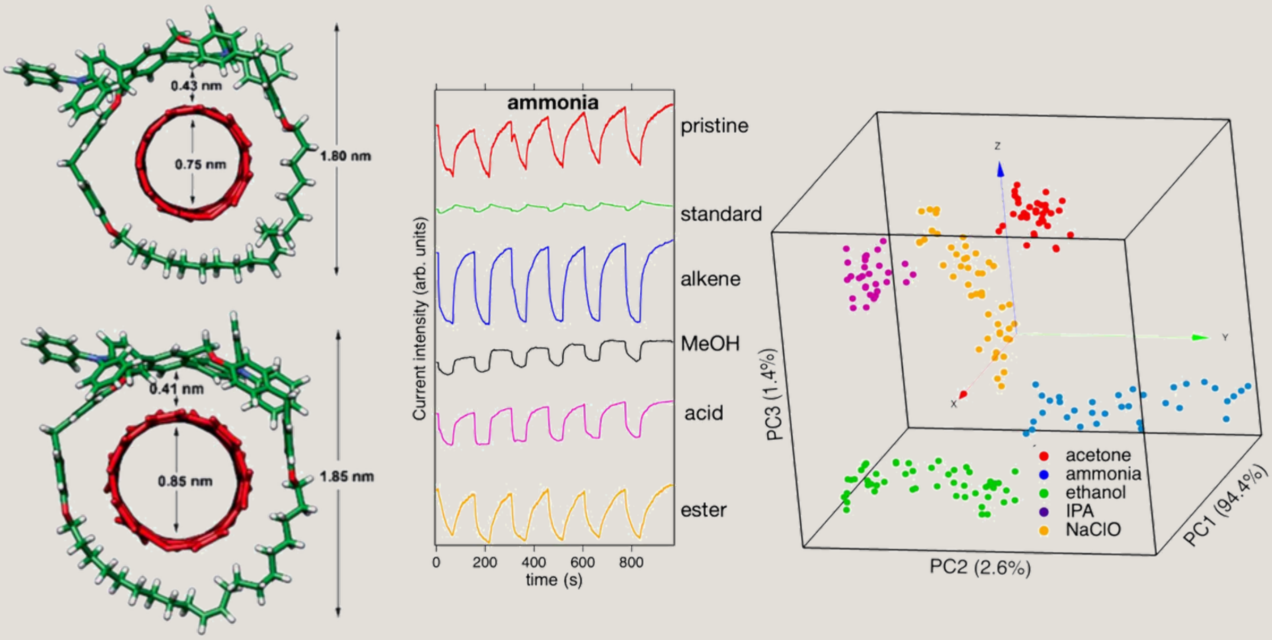
11 November 2024 14:30
Aula S4

Supervisor: **Luigi Sangaletti**

Gas sensors play a fundamental role in a wide variety of fields, including air quality monitoring and the food and beverage industry. The development of sensor arrays based on nanostructured materials has generated significant academic interest, leading to numerous research programs focused on this topic.

This presentation introduces the concept of chemiresistor gas sensors, focusing on their working principles and highlighting their importance. We will then present chemiresistors based on mechanically interlocked carbon nanotubes (MINTs), not only focusing on the nature of MINTs, but also examining their Raman characterization.

Additionally, various examples of gas exposure experiments will be shown. After presenting the sensors' responses and times, a particular attention will be given to the array's capability to discriminate between different target gases. Specifically, three different approaches will be considered: scatter plots, principal component analysis (PCA), and UMAP.



The effect of surface states accumulation on photo-electrochemical performances of $Bi_{24}Fe_2O_{39}$ grown by supersonic beams

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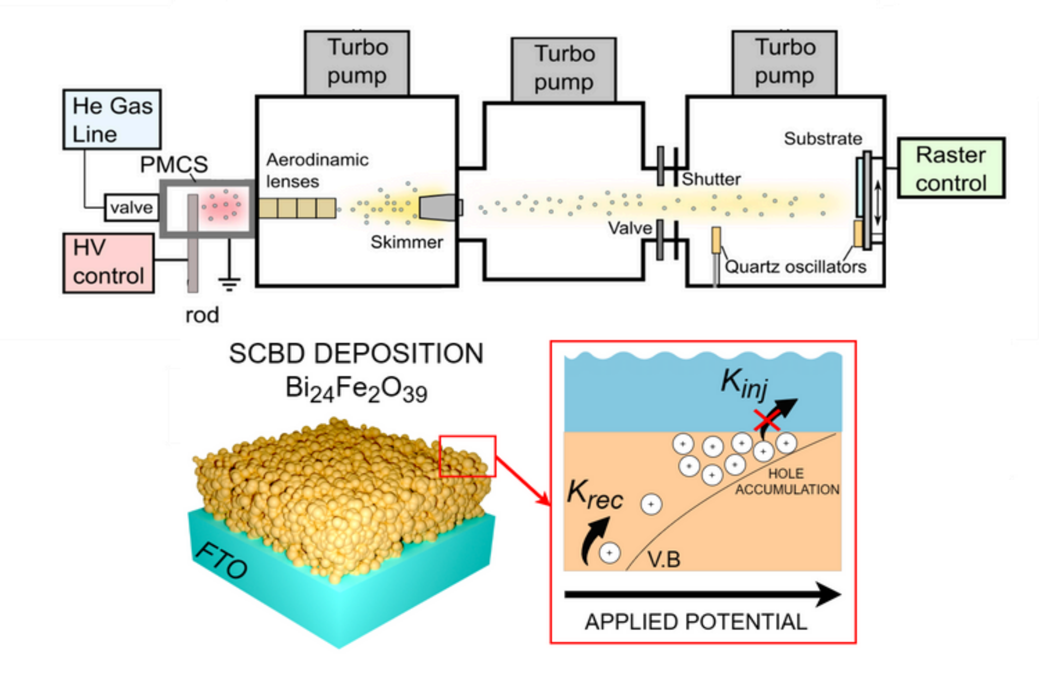
18 November 2024 14:30
Aula S4

Supervisor: **Luca Gavioli**

Holes accumulation on the surface of bismuth ferrite oxides (BFO) photoanodes for photoelectrochemical (PEC) water splitting (WS) is one of the major issues limiting the overall cell efficiency. However, among the various BFO crystal structures, no evidence of this mechanism has been reported for $Bi_{24}Fe_2O_{39}$, a scarcely investigated phase. Herein we characterize the morphological, structural and PEC properties of 100 nm thick nanogranular films of a $Bi_{24}Fe_2O_{39}$ single phase synthesized by supersonic cluster beam deposition. The films were tested as photoanodes for the WS reaction in KOH and Na2SO4 + Na2SO3 electrolytes. The PEC data provide direct evidence of holes accumulation on the surface of the material with increasing applied biases. The interesting performances of this material at low biases suggest a possible use as photocatalyst under visible light irradiation.



Visualizing Quantum Dynamics: The Role of Ultrafast Imaging in TMDs Studies

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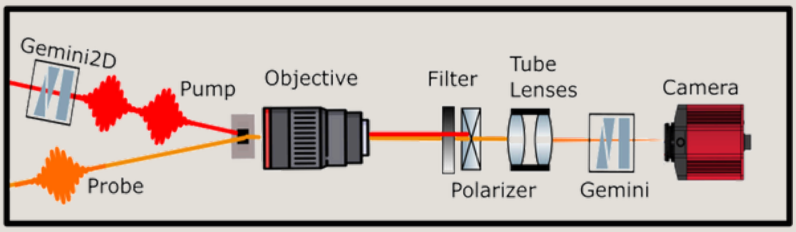
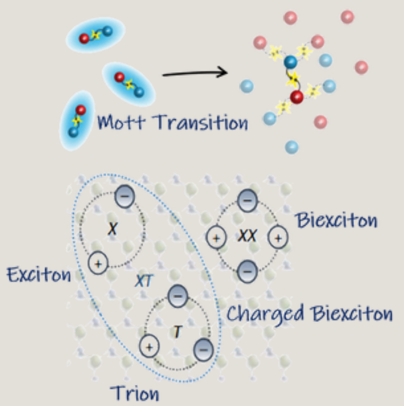
25 November 2024 14:30
Aula S4

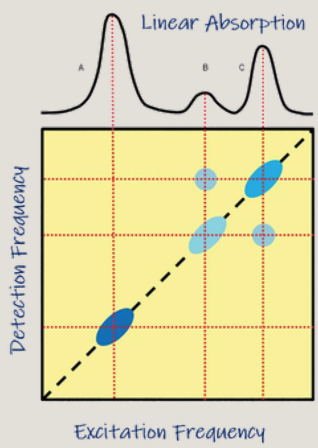
Supervisor: **Claudio Giannetti**

We will discuss our research on the dynamic characterization of excitons in Transition Metal Dichalcogenides (TMDs), a class of 2D materials with unique electronic properties. To study these materials in detail, we developed an experimental setup that combines time, spectral, and spatial information. Specifically, we use a pump-probe spectroscopy technique, which allows us to observe how the material responds to short laser pulses over time. However, since the regions we are interested in are extremely small, we incorporated a microscopy system to enhance spatial resolution and focus on specific areas of the sample.

Throughout our study, we have focused on the interplay between space and time to uncover new insights into the coherence (and loss of coherence) of excitons. By combining this new experimental technique with advanced image processing and data analysis tools, we aim to push the limits of our understanding of these quantum materials and open up new possibilities for their application in next-generation electronics and quantum technologies.







Global flux-based ozone risk assessment for wheat up to 2100 under different climate scenarios

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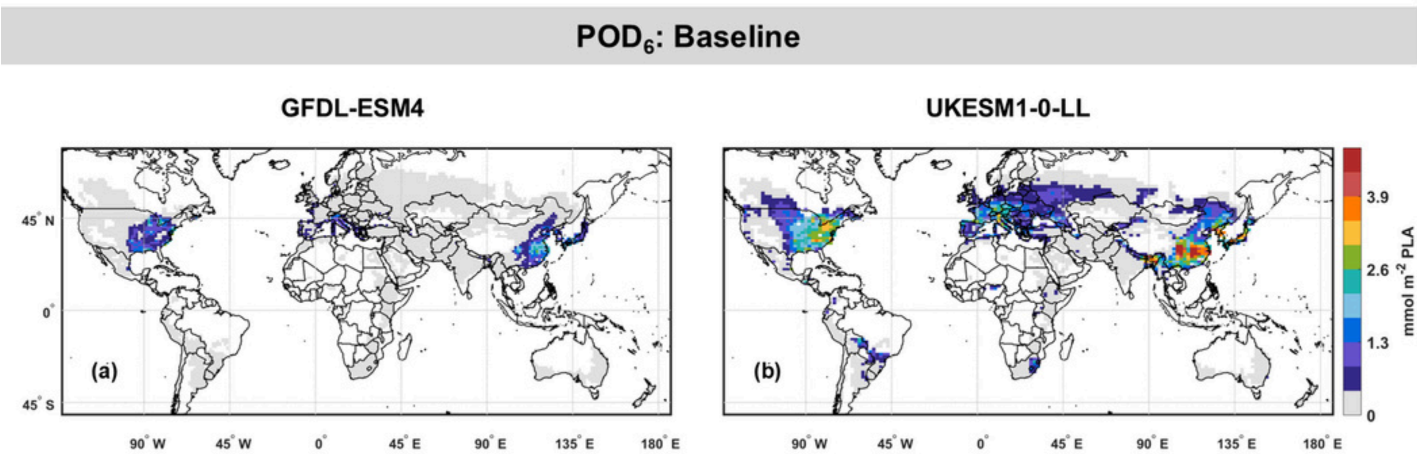
02 December 2024 14:30
Aula S4

Supervisor: **Riccardo Marzuoli**

The negative effects of tropospheric ozone (O3) on vegetation can lead to reduced photosynthesis, accelerated leaf senescence, and other negative outcomes which affect crop yields and biodiversity. This study presents a flux-based assessment of the global impact of O_3 on bread wheat (Triticum aestivum) for the 21st century, under various climate scenarios (Shared Socioeconomic Pathways, SSPs). A dual-sink big-leaf dry deposition model is employed to estimate the phytotoxic ozone dose (POD) absorbed by wheat through stomata, integrating data from two Earth System Models (ESMs) from the Coupled Model Intercomparison Project 6 (CMIP6). The study explores spatial and temporal variations in O_3 concentrations and the effects of climate variables on stomatal conductance, explaining changes in POD from the present time to the century's end. The results indicate significant regional disparities in O_3 dose for wheat, particularly under weak O3 precursor emissions control scenarios. However, in some regions, changes in POD may be driven more by climate variables and their interaction with O3, rather than by O3 concentrations alone. Therefore, this study emphasizes the need for effective emission mitigation policies of both O_3 precursors and greenhouse gases to preserve global food security from O_3 damages.



Disorder-Enhanced Transport in a one-dimensional quantum wire with power-law hopping

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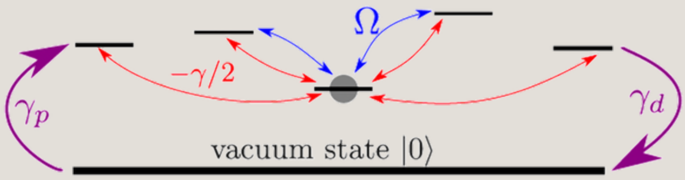
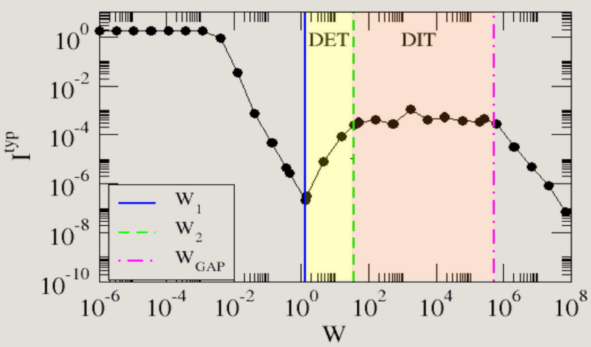
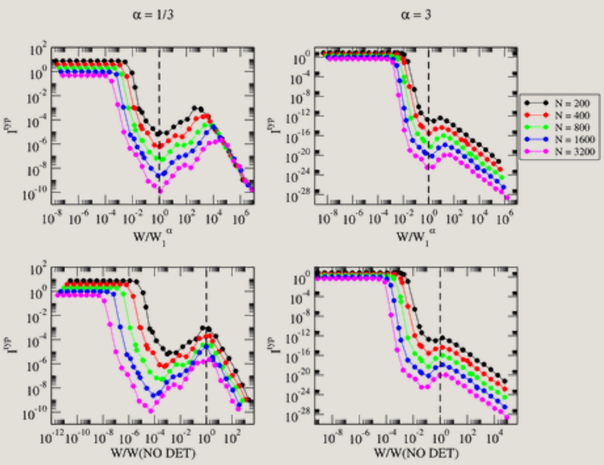
09 December 2024 14:30
Aula S4

Supervisor: **Fausto Borgonovi**

In many physical systems, disorder is often associated with a reduction in transport efficiency, leading to a phenomenon known as localization, where excitations become trapped, and movement is not allowed. Recent studies on one-dimensional chains of sites, where each site can interact with all others, have revealed surprising behavior: adding a small amount of disorder initially reduces transport, but increasing the disorder further can actually enhance transport. This phenomenon is known as the Disorder-Enhanced Transport (DET) regime. If the disorder continues to increase, the system eventually reaches a state where transport becomes independent of the amount of disorder called the Disorder-Independent Transport (DIT) regime. Our research explores whether these counterintuitive regimes - DET and DIT - persist when the interactions between sites are not uniform but instead follow a power-law dependence, meaning that the strength of interactions decreases with the distance between sites. This scenario is more realistic in many physical systems where interactions naturally become weaker over longer distances. We find that even when interactions decay with distance, the DET regime still emerges, showing that this phenomenon is robust under different interaction patterns.







Biomolecule mapping and identification via optical microscopy techniques (BioMAP)

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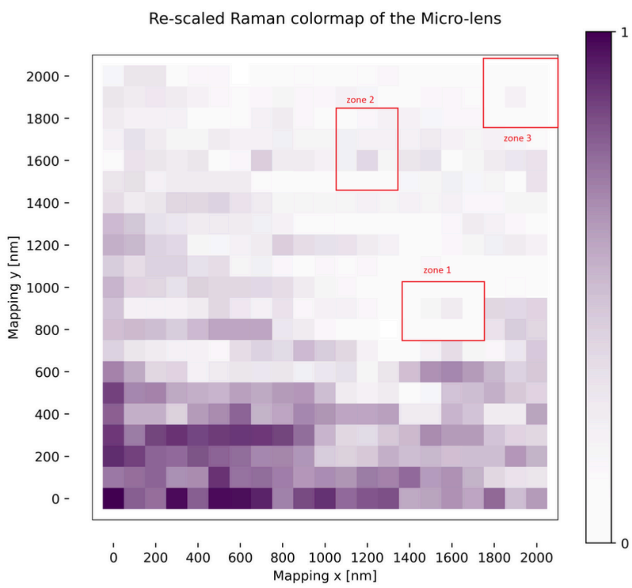
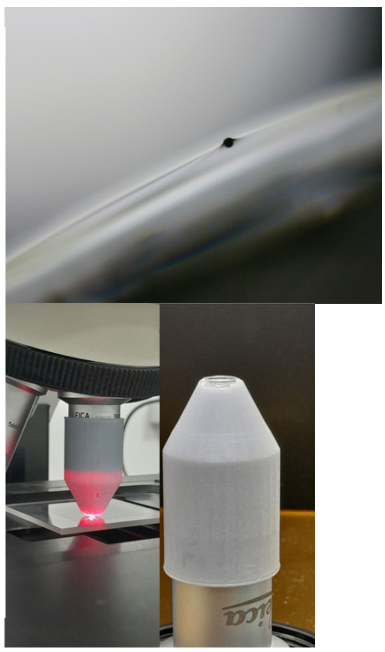
16 December 2024 14:30
Aula S4

Supervisor: **Gabriele Ferrini**

The optical mapping of biomolecules is an important topic in modern biology and medicine. The ability to capture signatures from native microbial DNA molecules (without amplification or library preparation) or features connected to biomolecules associated with diseases enables a new way to analyze biological specimens. We assembled a compound objective constituted by a high-index microsphere and a low numerical aperture (NA) objective. The compound objective was put to the test by enhancing the Raman signal of single-layer and multi-layer graphene and nanodiamond nitrogen-vacancy nanoparticles (NDNV) in a non-contact scanning mode. To assemble the compound objective, a 60 µm diameter barium titanate glass (BTG) microsphere was glued on a plano-convex lens and then mounted on a 3D-printed holder fit on a Leica 5X objective. The experiments showed that by using this new objective the Raman intensity on nanoparticles is several times higher compared to using a high NA objective (Leica 100X). It was found that the signal intensity strongly depends on the distance between the microsphere and the sample surface. The optimal distance is between 1 and 2 µm for the used microsphere and should be adjusted for different materials. The lateral resolution, is believed to be of the order of 100 nm but further work is needed in this direction.





Snapping nanoscale resistive switching in V_2O_3

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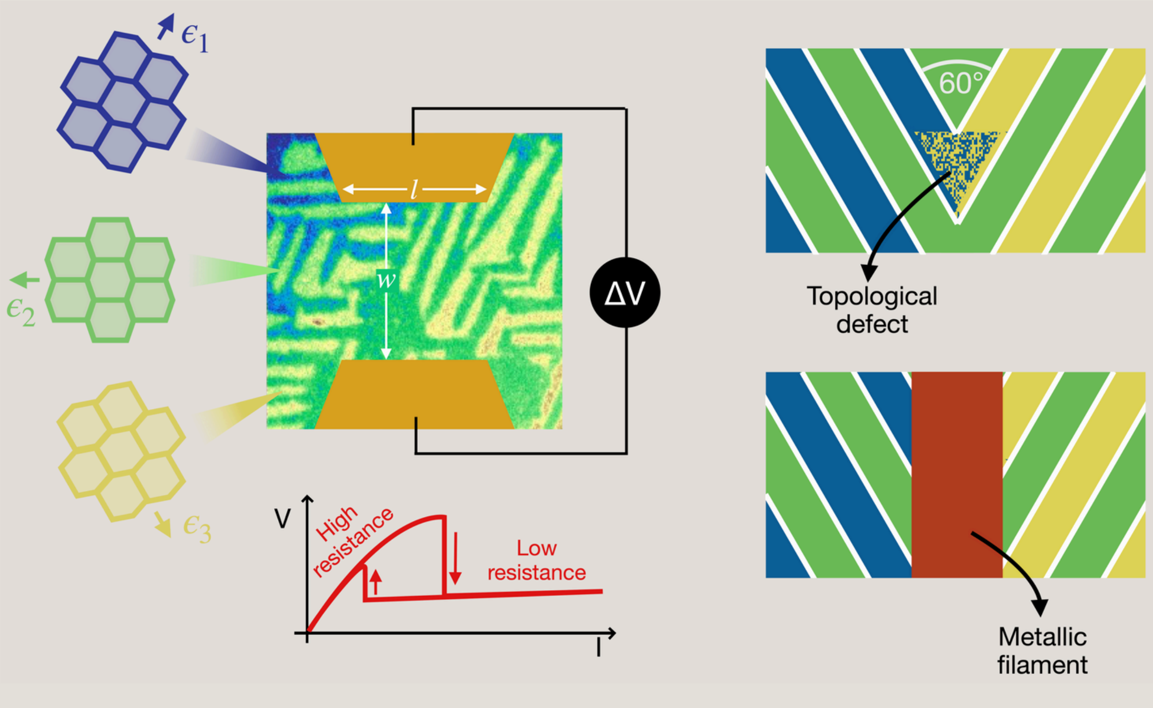
13 January 2025 14:30
Aula S4

Supervisor: **Claudio Giannetti**

The reversible and ultrafast manipulation of the electronic properties of materials is one of the main goals of the research in solid state physics and materials science. Mott insulators are promising materials where the temperature-driven insulator-to-metal transition (IMT), characterized by a resistivity change of several orders of magnitude, can also be induced by external perturbations, such as application of local electric fields (resistive switching) or excitation with ultrashort light pulses.

Here, we focus on vanadium sesquioxide, V_2O_3, a prototypical system showing a transition from a low-temperature antiferromagnetic (AF) insulator to a high-temperature paramagnetic metal (T_{imt} ~ 160 K). Using operando X-ray nano-imaging (photo-electron emission microscopy, PEEM), we have captured the origin of resistive switching in a V_2O_3-based device under working conditions. We reveal a new class of volatile electronic switching triggered by nanoscale topological defects appearing in the shear-strain based order parameter that describes the insulating phase. Our results pave the way to the use of strain engineering approaches to manipulate such topological defects and achieve the full dynamical control of the electronic Mott switching.



Tracking the early-stage dynamics in the layered semiconductor BiI_3

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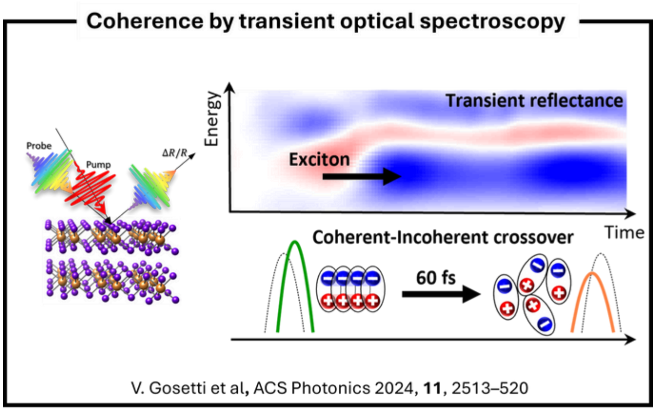
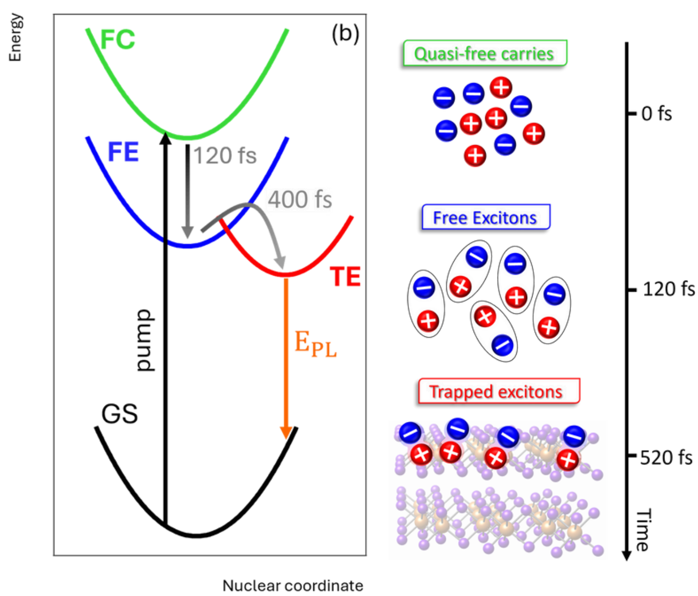
20 January 2025 14:30
Aula S4

Supervisor: **Stefania Pagliara**

Exciton physics dominates the optical and electronic properties of semiconductors, thus making fundamental research on how excitons emerge and the following relaxation pathways essential for future development in optoelectronics, valleytronics, and spintronics. BiI_3 is an ideal platform to study exciton dynamics since it exhibits exciton with binding energy higher than conventional 3D semiconductors. This results from the reduction of the dielectric screening due to the geometrical confinement of the excitonic wavefuncion produced by its layered structure and the hollow region within the planes. The goal of this talk is to provide a comprehensive characterization of the early-stage exciton dynamics with ultrafast spectroscopies, focusing mainly on two aspects: exciton coherence and formation. First, at low temperatures and with a pump photon energy quasi-resonant to the excitonic line, the light-matter interaction produces a coherent state that lasts only a few tents of fs after the pump arrival. Here, I will describe how the spectroscopic signature of exciton coherence has been investigated and the excitonic decoherence measured by transient optical spectroscopy.
Secondly, we followed the exciton formation dynamics and its subsequent localisation to trapped exciton in multidimensional space by time-resolved angle-resolved photoemission (tr-ARPES), exploiting a pump photon energy well above the energy gap of the material.





Multiscale Modelling of Fluid Flow in a Lymph Node

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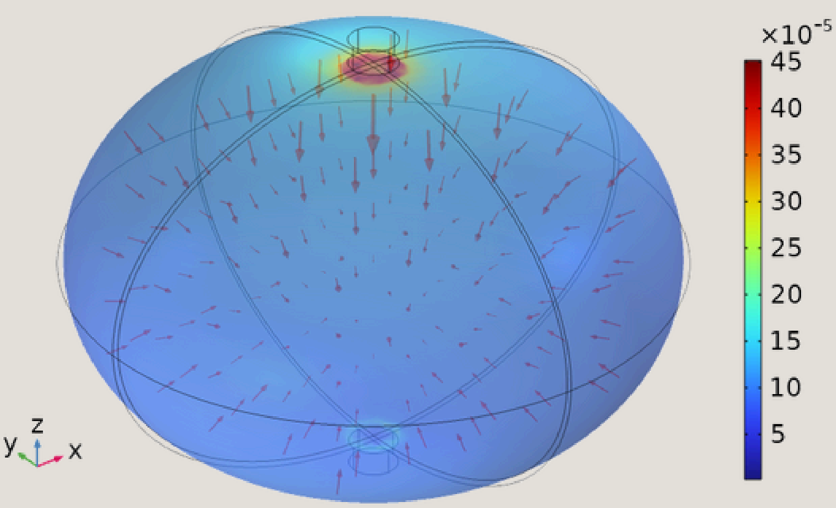
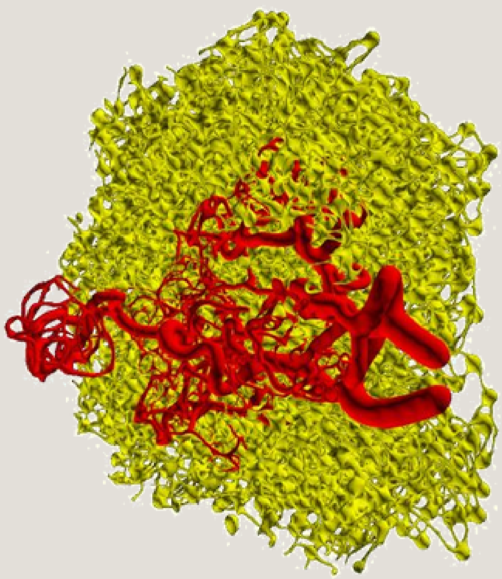
27 January 2025 14:30
Aula S4

Supervisor: **Giulia Giantesio**

Lymph nodes are crucial components of the lymphatic system, playing an essential role in our immune response by filtering bacteria, viruses, and waste from the lymph. These nodes act as biological filters, strategically located throughout the body to intercept and process foreign particles and pathogens. The main mechanical features of the lymph node include the presence of a porous bulk region, known as the lymphoid compartment, densely packed with immune cells. This compartment is surrounded by a thin layer called the subcapsular sinus, where the lymph fluid can flow freely, allowing for efficient transportation and filtration. Understanding the fluid dynamics within lymph nodes is essential for elucidating the mechanisms of immune surveillance and response, as well as for developing therapies for immune and lymphatic disorders. In this talk, we will explore a mathematical description that captures the multiscale nature of fluid flow within lymph nodes using asymptotic homogenization techniques. This advanced mathematical approach allows us to model the complex interplay between different scales of fluid movement within the lymph node. We will discuss how this model can elucidate flow patterns, pressure distribution, and shear stress within the node, providing insights into the mechanical environment that supports immune cell function and pathogen filtration.





Asynchronous Optical Sampling (ASOPS) study on Multilayer Graphene

Lishin Thottathi
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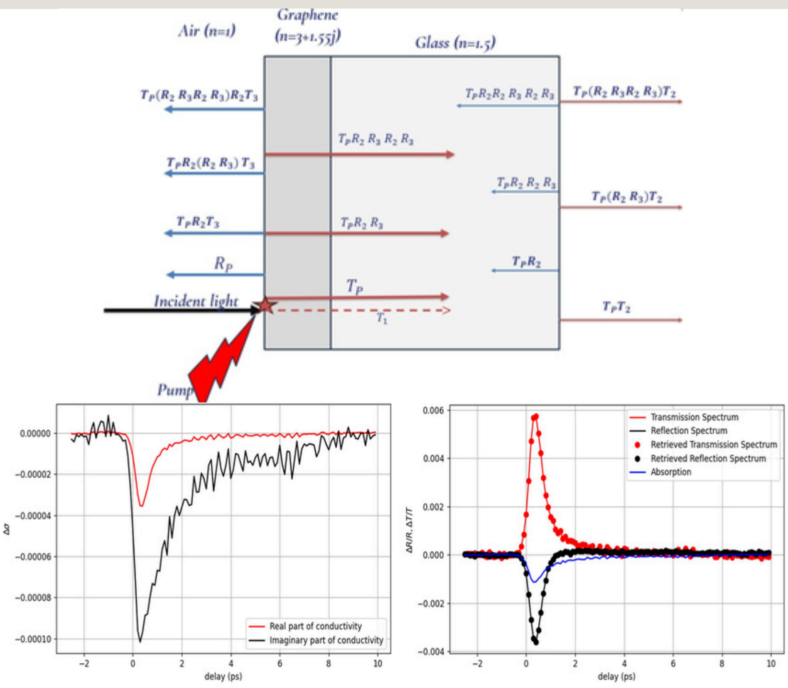
24 February 2025 14:30
Aula S4

Supervisor: **Gabriele Ferrini**

ASOPS is a time resolved pump probe techniques to characterize the non-equilibrium dynamics of a materials in femtosecond time scale. In a pump probe technique, we excite the sample by using a high intensity laser (pump), and measure the changes in the materials with another laser of low intensity (probe). By understanding this non equilibrium state of the material we will be able to understand the electronic evolution of the materials. In our time resolved study, we designed the instrument for taking both transmission and reflection signals simultaneously with a lateral resolution for characterizing a thin film material deposited on a transparent substrate. By this method we will be able to find the true absorption and a clearer picture of the electronic dynamics. In this talk I will discuss the characterization results of the material multilayer graphene with 65 layers. By combining the transient transmission and reflection with theoretical model we extract the change in optical conductivity (both real and imaginary part), absorption and the electron temperature peak as a function of the time delay between the pump and probe lasers for various pump intensities. I will discuss how the model explains the material response from high to low pump intensities and how we will get the change in optical properties as a function of the time delay.



Coupled Phonon-Spin Wave Dynamics in Layered CrI_3 Semiconductors: A Deep Dive into Magnetic and Lattice Interactions

Matteo Cossetto
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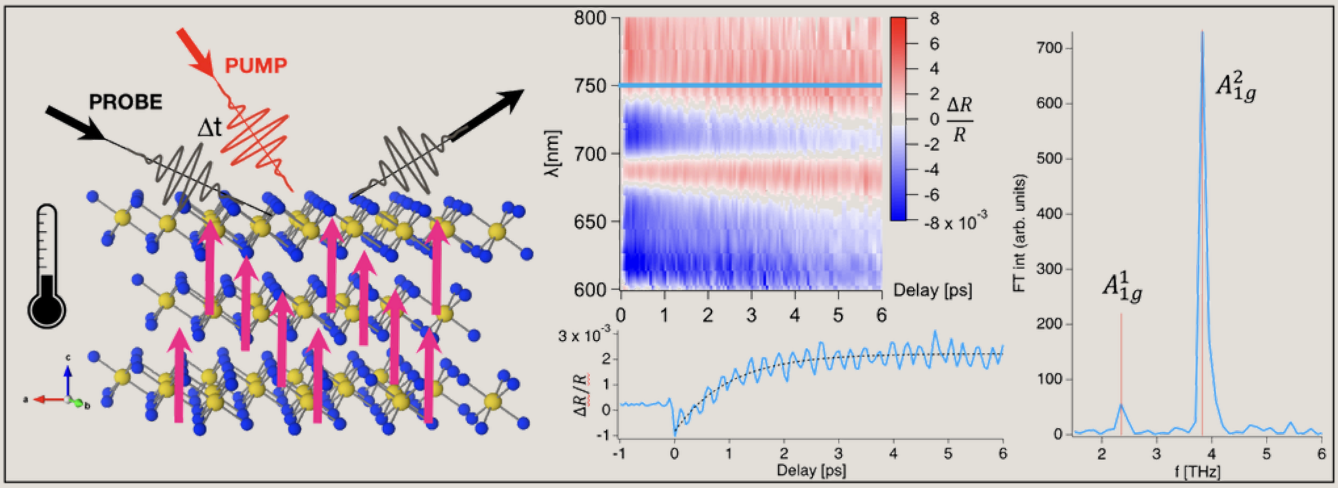
03 March 2025 14:30
Aula S4

Supervisor: **Stefania Pagliara**

This work presents Chromium(III) iodide, a magnetic compound at low-temperature of particular interest due to its anisotropic magnetic properties and van der Waals layered structure, which make it an ideal candidate for studying the coupling between phonons and magnons. CrI_3 is notable to maintain magnetic order down to a single layer, a rare feature in two-dimensional semiconductive materials, and for its potential in advanced applications. The interaction between lattice phonons across different layers and spin waves (magnons) in the material's magnetic phase has been investigated using ultrafast broadband pump-probe spectroscopy. Laser-induced strain waves between the atomic layers of CrI_3 generate acoustic phonons that, mediated by lattice deformation, influence magnetic excitations. Preliminary measurements reveal the mechanisms of phonon-magnon coupling. Understanding this interaction between lattice vibrations and spin waves in CrI_3 is crucial for the development of modern technologies, where the precise control of spin waves through lattice deformations could enable faster data processing in spintronics, optoelectronics, and other emerging fields. These results provide new insights into the fundamental interactions between strain-induced phonons and magnons in van der Waals magnetic materials.



Terahertz Spectroscopy and application in food industry

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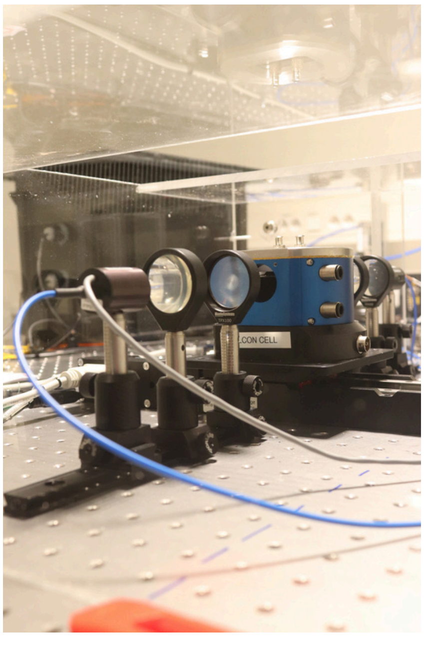
10 March 2025 14:30
Aula S4

Supervisor: **Claudio Giannetti**

Terahertz Time-Domain Spectroscopy (THz TDS) is emerging as a powerful tool for the food industry, offering non-invasive and highly sensitive techniques for food quality control and contaminant detection. The unique properties of terahertz waves, which lie between the microwave and infrared regions of the electromagnetic spectrum, make them ideal for penetrating common food products while providing detailed information about their molecular structure. THz TDS can be used to measure key parameters such as moisture content, detect foreign bodies (e.g., plastics, metals, and biological contaminants), and analyze the dielectric properties of food materials. This allows for the identification of impurities, ensuring product safety and quality. Furthermore, THz TDS enables the characterization of food textures and structures by assessing the absorption and scattering behaviors of terahertz waves in different materials. As the food industry increasingly focuses on automating inspection systems and meeting strict safety standards, THz TDS presents an effective solution for real-time, inline monitoring of food products. With the ability to complement other techniques such as X-rays and microwaves, THz TDS can enhance the detection of low-density contaminants that other methods might miss. The integration of THz TDS into industrial applications has the potential to revolutionize food safety, offering unprecedented precision in detecting and identifying contaminants while maintaining product integrity.



Modeling and simulations of cardiovascular system in pathological situations

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17 March 2025 14:30
Aula S4

Supervisor: **Giulia Giantesio**

This doctoral project focuses on developing a mathematical and numerical model to describe blood flow behavior and cardiac electrical signals in pathological conditions, such as chronic venous disease (CVD) and coronary artery disease (CAD), both of which are prevalent and clinically significant. CVD, affecting approximately 40% of the population, and CAD, the leading cause of death globally, often necessitate drug therapies or surgical intervention. The project aims to build a continuum mechanics framework to simulate blood flow dynamics and cardiac electrical activity under such conditions, where blood is modeled as a Newtonian or Non-Newtonian fluid, accounting for factors like blood viscosity and hematocrit levels.

Polystyrene beads refractive index determination for nanoplastic characterization

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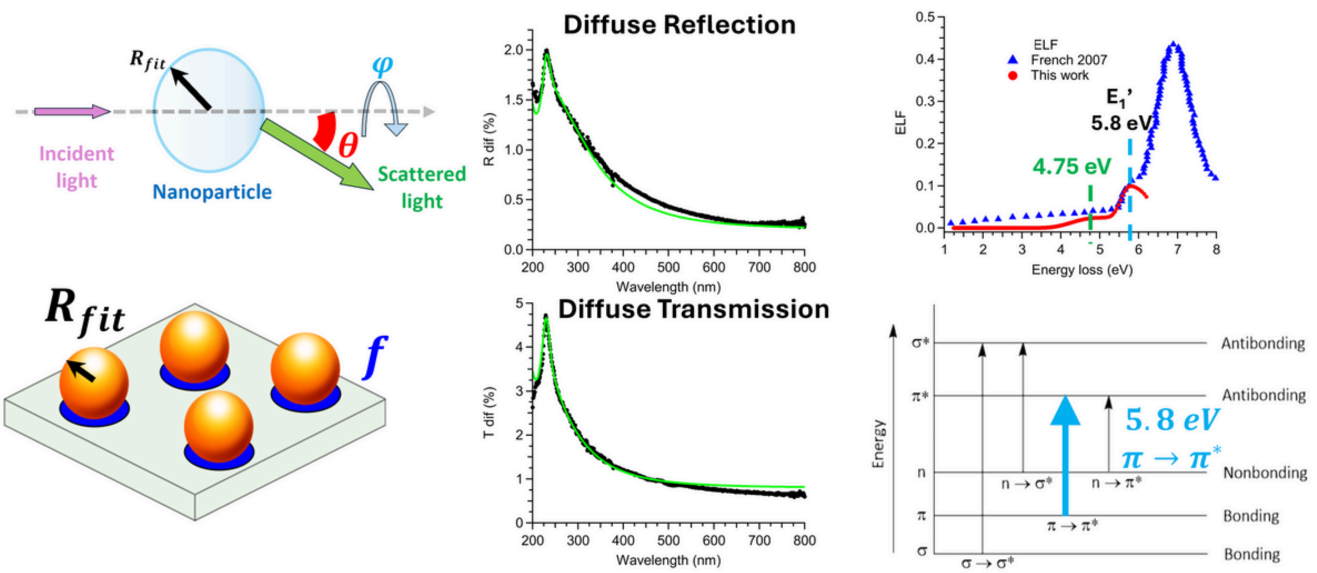
24 March 2025 14:30
Aula S4

Supervisor: **Luca Gavioli**

Nanoplastics, such as polystyrene beads (PSbs), are recently bursting in the environment while their effects on both human health and environment are still being pondered. Moreover, the characterization of the smallest nanoplastics in the environment is still challenging due to the lack of recognition markers. PSbs are also widely used in many scientific research fields, such as phantoms in biomedical optics or in particle detection techniques, which rely on the precise calculation of PSbs refractive index. Nevertheless, a complete view about PSbs optical and scattering properties, as well as their refractive index, is still lacking, in particular for wavelength less than 400 nm and for PSbs of nanometric sizes. This work investigates optical properties of 55 nm radius PSbs to compute the refractive index and provide a link between morphology, dielectric function and optical excitation energies. A model based on Mie theory is proposed to reproduce total and diffuse reflectance and transmittance spectra and to retrieve the refractive index, as well as some morphological parameters, by means of a fitting procedure. The interband transition strength and energy loss function, related to the electronic and optical excitations, are calculated and compared with available data from the literature. The relation between our model results and the physical transitions energies, which may identify chemical bonds involved or specific PSbs features, highlights the potential of this approach for nanoplastic recognition and characterization.



A Logic-Probabilistic Method to Compare Quantum Sample Classification Under Absence of Ground Truth

Cassio Rodrigo Cristani
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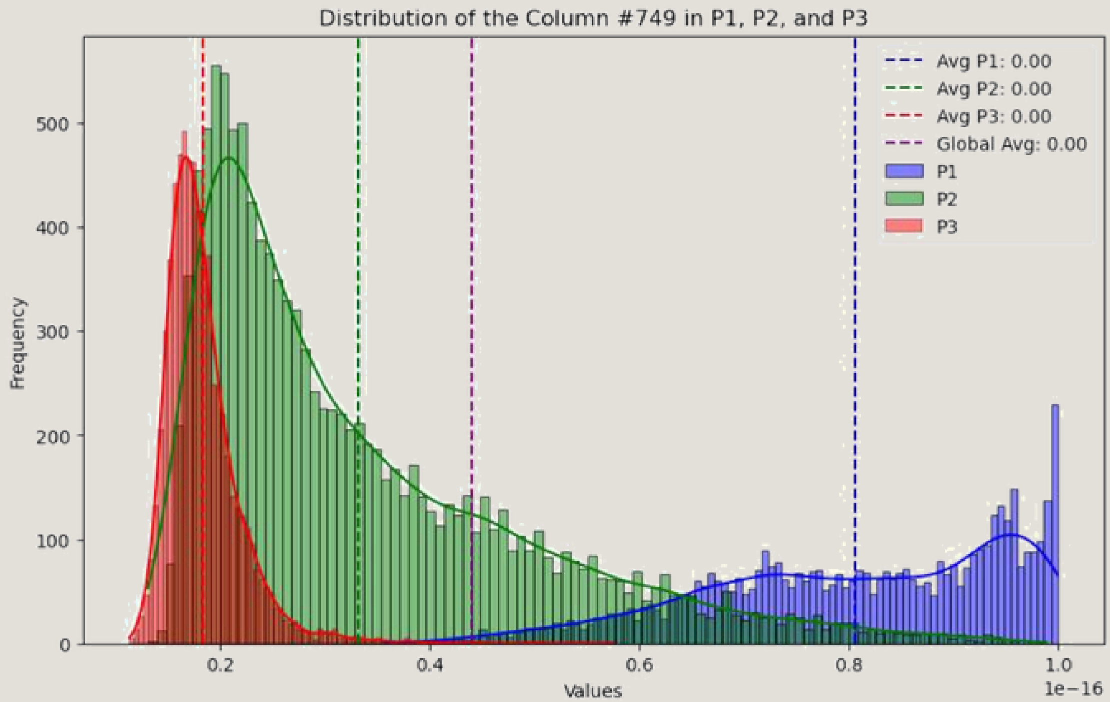
31 March 2025 14:30
Aula S4

Supervisor: **Daniele Tessera**

One approach to investigate the existence of the third phase is by using clustering algorithms to identify the number of distinct groups. Unsupervised methods are likely to be used as they do not require prior settings. However, the convex nature of the problem does not present a function to minimize, making the task of comparing different algorithms a big challenge. An approach that overcomes this gap would be using supervised learning to evaluate outcomes against a benchmark. This raises the importance of a method to fairly compare the outcomes and be used as an inference instrument.

In this work, we introduce a logical-probabilistic method that analyzes individual features of an eigenstate, providing precise algorithmic confidence and uncertainty for each phase. This approach enables a deeper analysis of each method, revealing which eigenstate features contribute to predictions and which energy levels lead to misclassification. It also facilitates the development of a benchmarking framework to track the performance of each method, allowing for fair comparisons and improvements in phase classification, advancing research even in the absence of a definitive ground truth.



Cooling-Induced Order-Disorder Phase Transition in $CsPbBr_3$ Nanocrystal Superlattices

Umberto Filippi
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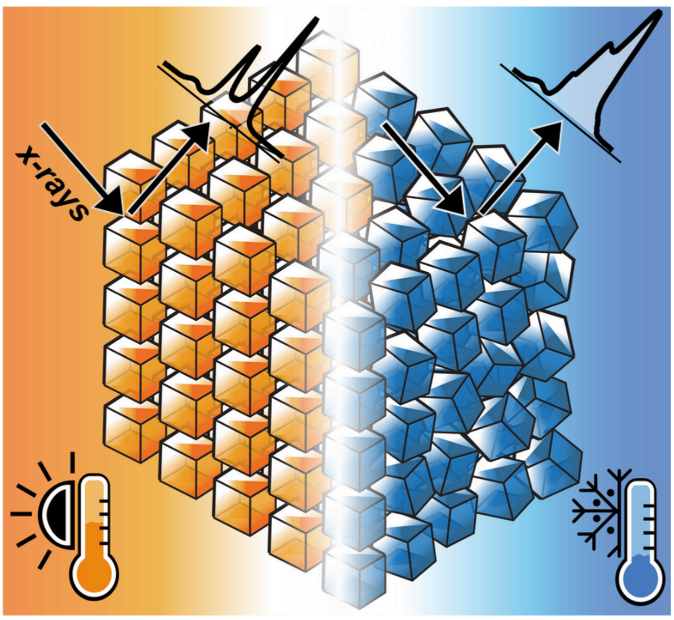
07 April 2025 14:30
Aula S4

Supervisor: **Liberato Manna (IIT Genova)**

Perovskite nanocrystal superlattices are highly ordered assemblies of nanocrystals separated by layers of surface-bound ligands. They recently attracted attention after reports have emerged on collective excitonic properties at cryogenic temperatures, where energetic disorder is minimized due to the frozen lattice vibrations. However, an important issue related to structural disorder of superlattices at low temperatures has received little attention to date. In this presentation I will show that $CsPbBr_3$ nanocrystal superlattices undergo a reversible order-disorder transition upon cooling to 90 K. The transition consists of the loss of structural coherence, i.e. increased nanocrystal misalignment, and contraction of the superlattices, as revealed by temperature-dependent X-ray diffraction, and is ascribed to the solidification of ligands (on the basis of Raman spectroscopy). Introducing shorter amines on the nanocrystal surface allows to mitigate these changes, improve order, and shorten interparticle distance. In addition, I will show that the low temperature phase of the short ligand-capped nanocrystal superlattices is characterized by a strong exciton migration observable in the photoluminescence decay, which is due to the shrinkage of the inter-nanocrystal distance.



A variational problem for nematic films

Chiara Lonati
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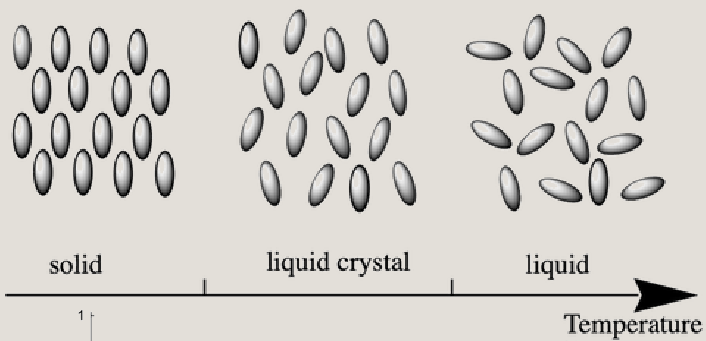
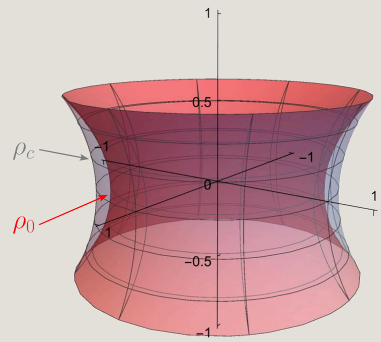
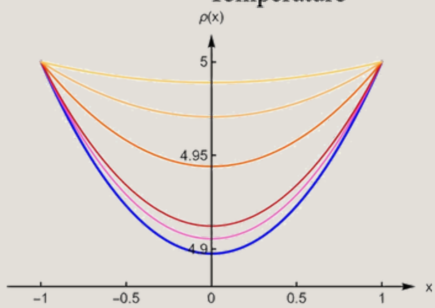
14 April 2025 14:30
Aula S4

Supervisor: **Alfredo Marzocchi**

Nematic surfaces are thin structures made of specific liquid crystals whose orientation is described by a nematic director that usually tends to be constant. After a brief introduction on the main phases of these objects and the principal models introduced to describe them, we will deal with a problem that we recently studied. Two variational models were introduced in 2012 and 2018 respectively by Giomi and Napoli & Vergori. The functionals introduced reflect the competition between the surface tension, which favors the minimization of the area, and the nematic elasticity, which instead promotes the alignment of the molecules along a common direction. In particular, the material contribution penalizes the surface gradient of the director: Giomi used the covariant derivative of the director, while Napoli & Vergori dealt also with the effect of the underlying curvature of the surface. Our recent results concern the variational analysis of the problem proposed by Giomi for revolution surfaces spanning two coaxial rings, where Frank energy is assumed for the crystal. Proceeding as in Greco's work by a convexification argument and exploiting the classical study of the catenary, we prove the existence of an equilibrium shape, i.e. a minimizer for the energy, that is even, strictly convex, lies above the catenary and tends to be a straight line when the nematic prevails.







Artificial intelligence and artificial olfaction

Machine learning applied to physics

Michele Zanotti
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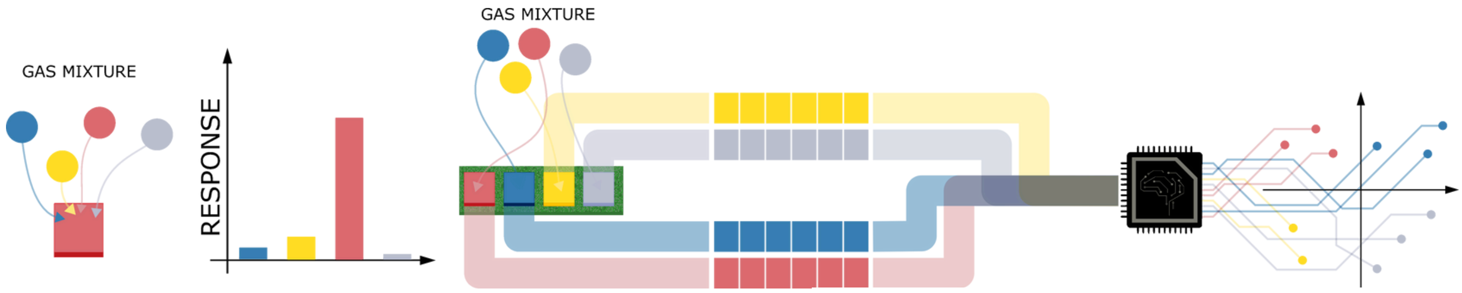
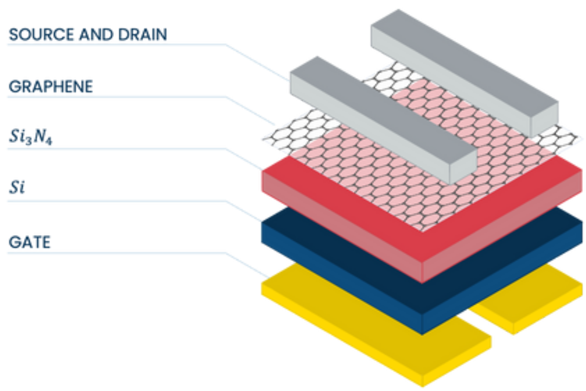
28 April 2025 14:30
Aula S4

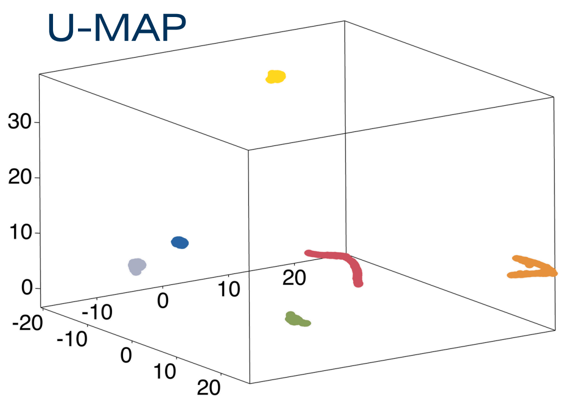
Supervisor: **Luigi Sangaletti**

This presentation introduces a groundbreaking approach to gas sensing, built on the virtualization of a single Graphene Field-Effect Transistor (GFET). Historically, electronic noses (e-noses) have used arrays of sensors to detect gases, a structure largely unchanged for decades. This innovative approach uses GFETs with sensor virtualization, creating a “virtual sensor array” from a single device by tuning the gate voltage. The presentation will delve into how this innovative GFET-based system achieves a 20-fold increase in sensitivity for detecting ammonia (NH_3) and other gases, even in the presence of interferents like nitrogen dioxide (NO_2). With the aid of machine learning algorithms such as Principal Component Analysis (PCA), Uniform Manifold Approximation and Projection (U-MAP), and Deep Neural Networks (DNN), this approach enhances the capability to analyze multi-dimensional sensor data, leading to highly accurate gas classification.

The potential impact of this technology is vast, with applications ranging from environmental monitoring to healthcare and food and beverage quality control. The discussion will highlight how this new architecture simplifies e-nose systems by eliminating multiple sensors, leading to more scalable, efficient, and compact gas sensing devices.







Influence of Surface Fe Content on the Photoelectrochemical Properties of $Bi_{24}Fe_2O_{39}$ Nanogranular Thin Films Deposited via SCBD

Michele Vergari
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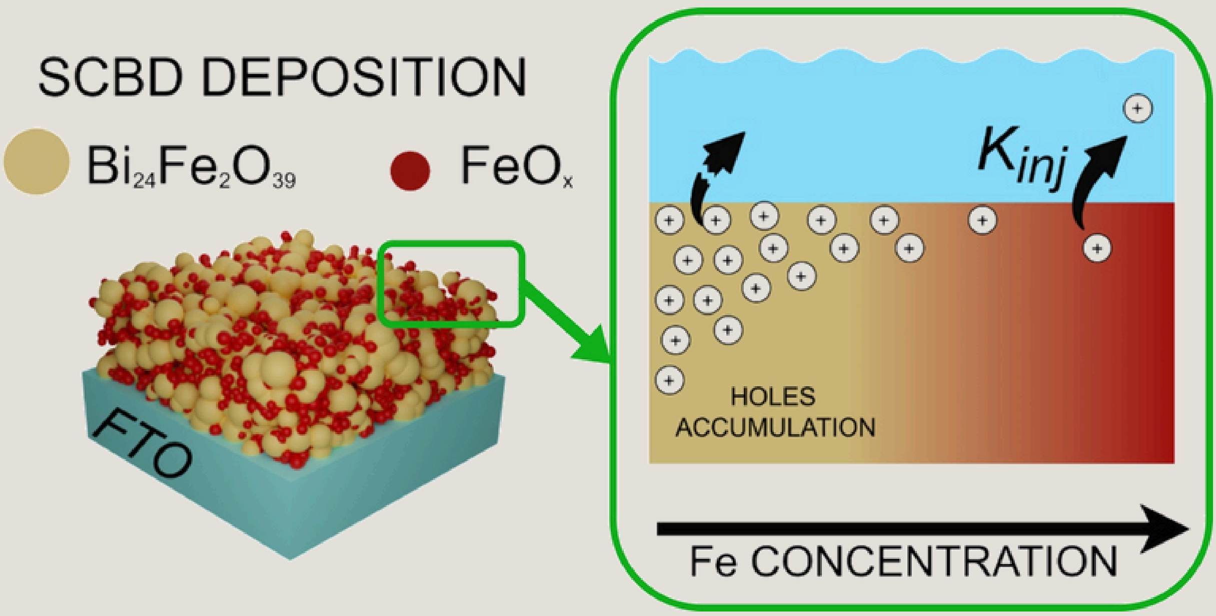
05 May 2025 14:30
Aula S4

Supervisor: **Luca Gavioli**

The quest for low-cost methods to produce renewable energy vectors is a global scientific and technological challenge. In this context, photoelectrochemical (PEC) water splitting represents a promising route, potentially allowing the large-scale generation of green hydrogen directly from solar energy. In the present work, composite films consisting of $Bi_{24}Fe_2O_{39}$ nanocrystals and an amorphous iron oxide (FeOx) phase have been fabricated by a pulsed micro-plasma cluster source (PMCS) coupled with supersonic cluster beam deposition (SCBD) on a fluorine-doped tin oxide (FTO) coated glass substrate, followed by air annealing. The use of BiFe targets with different compositions allowed to tailor the overall Bi:Fe ratio in the resulting electrode materials, that were tested as photoanodes for the hydrogen evolution reaction (HER), both in KOH and Na2SO3 as holes scavenger. From the PEC tests it was observed that pure Bi-rich phases, like $Bi_{24}Fe_2O_{39}$, suffer from charge accumulation at the surface, which leads to an upward shift in both the open-circuit potential (OCP) and the Fermi level, negatively impacting performance. However, the presence of Fe helps mitigate these issues. In particular, the charge injection efficiency is strongly improved by a lower Bi:Fe ratio, i.e., by a higher relative amount of the FeOx phase. The best-performing sample, with a Fe surface concentration more than double of Bi ones, exhibits an incident photon-to-current conversion efficiency (IPCE) above 4% at 400 nm and 1.23 V.



Characterization of Non-Stomatal Deposition of Ozone in Lowland Forests

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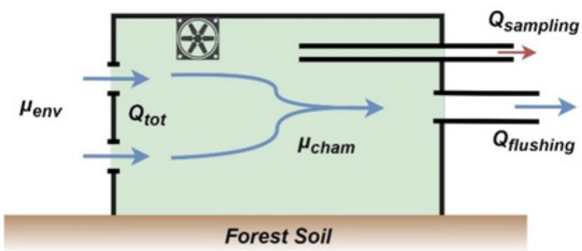
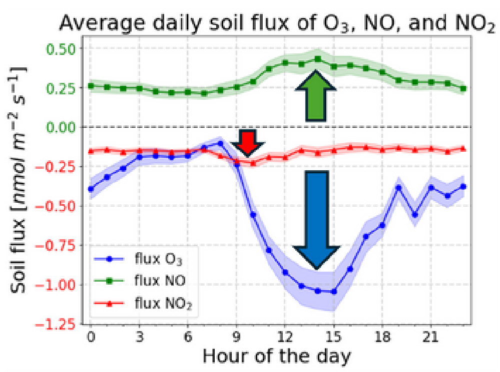
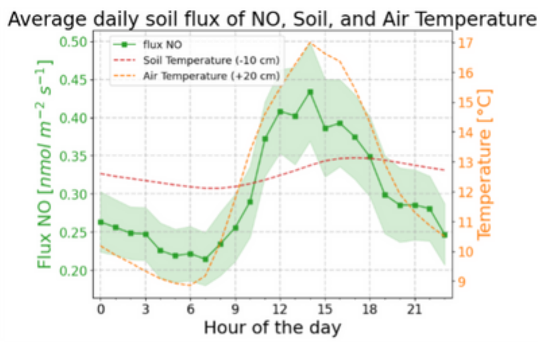
12 May 2025 14:30
Aula S4

Supervisor: **Riccardo Marzuoli**

Since the Industrial Revolution, tropospheric ozone (O_3) concentrations have increased significantly due to higher emissions of its precursors, including nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). Elevated O_3 levels contribute to three major environmental issues. First, O_3 is one of the most significant greenhouse gases in terms of effective radiative forcing, playing a crucial role in driving climate change. Second, it poses serious health risks, particularly to respiratory and cardiovascular systems. Third, O_3 negatively affects crop yields and ecosystem productivity, with annual crop losses estimated at $11–18 billion and reductions in gross primary productivity in European forests ranging from 0.4% to 30%. Understanding O_3 deposition in forests is essential for improving risk assessments and enhancing atmospheric models to account for O_3's broader environmental impacts. O_3 dry deposition in forests involves both stomatal and non-stomatal fluxes. While the stomatal flux is key to evaluating O_3 damage, accurate representation of non-stomatal processes is equally important. Non-stomatal pathways include O_3 deposition on forest soils, reactions with soil-emitted NO, and the influence of turbulence within the canopy. This seminar will present first results from a measurement campaign at the ICOS site of Bosco Fontana (IT-BFt), a broadleaf deciduous forest in the Po Valley. A dynamic chambers system was implemented to measure soil fluxes of O_3, NO, and NO_2. The functioning of the chambers system and a comparison of different methodologies for evaluating these fluxes will be discussed.







Operator Algebras in (quasi-)de Sitter and the no boundary proposal

Lihan Guo
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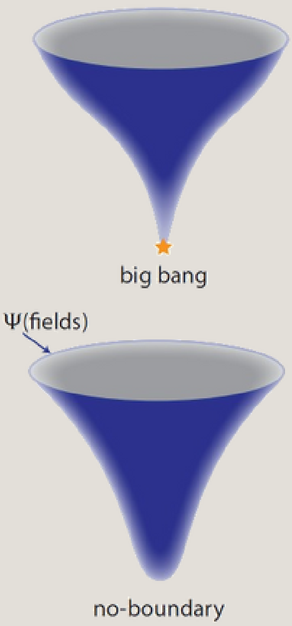
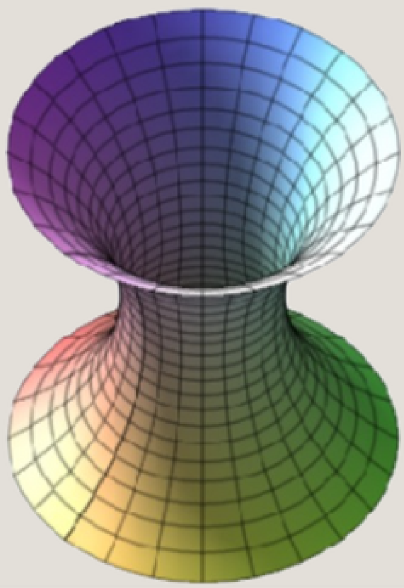
19 May 2025 14:30
Aula S4

Supervisor: **Giuseppe Nardelli**

De Sitter (dS) spacetime holds significance in theoretical cosmology. Important as it is, there are still a lot of mysteries around it. Previous work has successfully constructed an algebra of observables for dS space to understand its entropy better. For the next step, a natural question will be to ask what happens for the inflationary (quasi-dS) spacetime.
A clue for us is that it is proposed in the literature that the Hartle-Hawking no boundary state might be one way helpful for algebra construction universally. It's tempting to imagine that the quasi-dS spacetime fits in the box, but further investigation is required.
On the other hand, despite its elegant form, the no boundary state predicts most likely an empty universe and implies that we gain in probability by reducing the number of inflation e-folds. The combination of the algebra tool and this no boundary state shed light on solving the problem of the latter.
In this talk, I will mainly tell you the answer to the following questions for simple quasi-dS cases: How can this no boundary state help construct an algebraic description? How can the algebra language help solve the problems in the no boundary proposal?





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