



> polytopo

Topological textures: Experiments, Theory, Simulation
and Mathematical Analysis

15th – 18th of June 2026, Iași, Romania

Programme and Book of Abstracts



“Gheorghe Asachi” Technical University of Iași (TUIAȘI)





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SCIENTIFIC COMMITTEE

- Roger MOSER, University of Bath (chair)
- Dennis MEIER, University of Duisburg-Essen
- Michele RUGGERI, University of Bologna
- Emilia WITKOWSKA, Institute of Physics Polish Academy of Sciences

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“Gheorghe Asachi” Technical University of Iași, Romania

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- Răzvan-Dumitru CEUCĂ
- Georgeta CREȚU
- Marcel ROMAN
- Daniela ROȘU
- Oana STRUGARIU
- Radu STRUGARIU



PROGRAMME

Monday - 15th of June 2026

 Aula Magna “Carmen Sylva”

13:00 – 15:00 Registration at DMCS**

15:20 – 15:30 Welcome

15:30 – 16:30 **Claas ABERT**
Variational Physics-Informed Reconstruction of Topological Magnetic Textures

16:30 – 17:00 Coffee break

17:00 – 18:00 **Ionel Dumitrel GHIBA**
Shell Models in Classical and Cosserat Nonlinear Elasticity

18:00 – 18:20 **Stavros KOMINEAS**
POLYTOPO: Current Status and Future Plans

** DMCS = Department of Mathematics and Computer Science

Tuesday - 16th of June 2026

Room P7

08:30 – 08:45 Coffee

08:45 – 09:00 Poster session: **A. NAVALLUR, S. RUTA, D. BORODINAS**

09:00 – 10:00 **Gediminas JUZELIŪNAS**
Topological Sub-Wavelength Optical Lattices for Ultracold Atoms

10:00 – 10:30 Coffee break

10:30 – 11:30 **Maciej GAŁKA**
Realizing Integer and Fractional Quantum Hall States with a Few Rapidly Rotating Fermions

11:30 – 11:50 **Oleksandr DOBROVOLSKIY**
Superconductivity in Curved 3D Nanoarchitectures

11:50 – 12:10 **Amir CAPUA**
Detection of Spin Polarized Currents by Spin-Torque Skyrmion Resonance in a Frustrated Magnet

12:10 – 12:30 **Krisztián PALOTÁS**
Magnetic Skyrmions Probed and Manipulated by Spin-Polarized Scanning Tunneling Microscopy: Efficient Spin Switching

12:30 – 14:30 Lunch break

14:30 – 15:30 **Svitlana KONDOVYCH**
Topology and Critical Properties of Divergenceless Ferroic Textures

15:30 – 16:30 **Cameron SCOTT**
Tuning Polar Textures with Temperature Gradients

16:30 – 17:00 Coffee break

17:00 – 18:00 **Mauro António PEREIRA GONÇALVES**
Chasing Topological Texture in Polar Oxides

Wednesday - 17th of June 2026

Room P7

08:30 – 08:50 Coffee

08:50 – 09:00 Poster session: **D. CHEVIZOVICH, G. THEODOROU**

09:00 – 10:00 **Salia CHERIFI-HERTEL**
Nonlinear Optical Imaging of Polar Topological Textures in Ferroelectric Materials

10:00 – 10:30 Coffee break

10:30 – 11:30 **Marty GREGG**
Novel Topological Structures at Twisted Ferroelectric Interfaces

11:30 – 12:30 **Mara STRUNGARU**
Topological Spin Textures in 2D Magnets

12:30 – 14:30 Lunch break

14:30 – 14:50 **Oksana CHUBYKALO-FESENKO**
Novel Three-Dimensional Topological Magnetic Domain Walls and their Dynamics

14:50 – 15:10 **Levente RÓZSA**
Spin Inertia as a Source of Topological Magnons: Chiral Edge States from Coupled Precession and Nutation

15:10 – 16:00 Working group meetings

16:00 – 18:00 MC Meeting

Thursday - 18th of June 2026

 Room P7

08:30 – 09:00 Coffee

09:00 – 10:00 **Stavros KOMINEAS**
Dynamics of skyrmions in magnets and a memory effect

10:00 – 10:30 Coffee break

10:30 – 11:30 **Theresa SIMON**
Magnetic Skyrmions

11:30 – 11:50 **Shilpa DUTTA**
A Variational Approach to Ferronematics with a Stray Field Energy

11:50 – 12:10 **Theodora IOANNIDOU**
Construction of Novel Algebra

12:10 – 12:30 **Danial SAADATMAND**
Phonons Scattering off Discrete Asymmetric Solitons in the Absence of a Peierls–Nabarro Potential

12:30 – 14:30 Lunch break

14:30 – 14:50 **Maria KYRIAZI (GWIS)**
Participation in Science Is Designed: What Shapes Inclusion, Visibility, and Engagement in Research Communities

14:50 – 15:10 **Michele RUGGERI**
From Research to Society: Outreach Activities in Polytopo

15:10 – 15:30 **Ümit AKINCI**
Interlayer Interaction as a Mechanism for Engineering Topological Textures in Thin Films: From Meron Crystals to Induced Skyrmions

15:30 – 16:30 **Emanuela GUSSETTI**
Existence of Statistically Stationary Solutions to the Schrödinger Map Equation

16:30 – 17:00 Coffee break

17:00 – 18:00 **Giacomo CANEVARI**
Singular Perturbations of Manifold-Valued Maps: Topological Singularities and Compactness Results

18:00 – 18:10 Closing remarks

BOOK OF ABSTRACTS

Variational Physics-Informed Reconstruction of Topological Magnetic Textures

Abstract

Reconstructing three-dimensional magnetization textures from experimental data, such as NV magnetometry or X-ray tomography, constitutes a fundamentally ill-posed inverse problem. The non-uniqueness of stray-field sources, combined with experimental noise and resolution limits, requires the incorporation of physical constraints beyond purely mathematical inversion. In this work, we present a physics-informed variational reconstruction framework designed to enforce consistency with micromagnetic equilibrium.

The method embeds the full micromagnetic energy functional directly into the inverse problem, utilizing an auto-differentiable finite-difference solver. By combining FFT-based computations with gradient-based optimization, the framework enables the efficient extraction of physically consistent magnetization textures. This approach addresses the inherent ambiguities of inverse problems in magnetic imaging, providing a robust and quantitative route to characterizing complex topological configurations.

Presenter

 **Claas ABERT**

 University of Vienna

 Austria


Authors

1. ABERT, Claas — University of Vienna

Session Information

 **Location:** Aula Magna “Carmen Sylva”

 **Day:** 1 - Monday 15th

 **Time:** 15:30-16:30

 **Chairperson:** Roger MOSER

 **Presentation Type:** Oral presentation

Shell Models in Classical and Cosserat Nonlinear Elasticity

Abstract

In this talk, we present aspects of the derivation of several shell models in the framework of classical and Cosserat nonlinear elasticity. In addition, we address the well-posedness of the resulting models.

Presenter

Ionel Dumitrel GHIBA

 Department of Mathematics, Alexandru Ioan Cuza University of Iasi & Octav Mayer Institute of Mathematics of the Romanian Academy, Iasi Branch

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Session Information

 **Location:** Aula Magna “Carmen Sylva”

 **Day:** 1 - Monday 15th

 **Time:** 17:00-18:00

 **Chairperson:** Roger MOSER

 **Presentation Type:** Oral presentation

Positional memory of skyrmions in magnetic bilayers

Abstract

We numerically and analytically study the transient dynamics of magnetic skyrmions in synthetic antiferromagnets under a magnetic field gradient. We consider skyrmions in a bilayer with antiferromagnetic coupling between the layers. The skyrmions in the two layers move almost perpendicular to the field gradient and the motion is eventually halted with the two skyrmions at a distance from each other. We find that the skyrmion displacement is proportional to the field gradient, while the time it takes to reach their final position is almost independent of it. Below a critical magnetic field gradient strength, the system displays an unusual ‘remembering’ dynamics: when the magnetic field gradient is removed, the skyrmions return to their original positions to a high degree of accuracy. We explain this observation and other quantitative features using a moduli space dynamics approximation.

Presenter

 **Anusree NAVALLUR**

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Authors

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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 08:45-09:00

 **Chairperson:** N/A

 **Presentation Type:** Poster presentation

Spontaneous creation and annihilation dynamics of magnetic skyrmions at elevated temperature

Abstract

Magnetic skyrmions are topological spin textures whose stability and dynamics are strongly affected by thermal fluctuations, particularly in ultrathin chiral magnetic systems where competing interactions act on the atomic scale. A key challenge for their practical use is understanding how thermal fluctuations influence their nucleation, motion, stability, and annihilation. This is essential both for fundamental studies of topological matter and for assessing their robustness in realistic conditions. In this work [1], we investigate the spontaneous creation and annihilation dynamics of magnetic skyrmions in an Ir/Co/Pt ultrathin-film model using atomistic spin simulations parameterised from ab initio calculations, considering temperatures from 300 K to 500 K, with the 0 K configuration used as a reference state. Atomistic spin dynamics simulations are performed using VAMPIRE, enabling the investigation of complex topological spin structures at finite temperature. Our analysis focuses on the stochastic finite-temperature regime, investigated using VAMPIRE atomistic spin dynamics simulations [2], in which the system evolves under the combined influence of exchange, magnetic anisotropy, Dzyaloshinskii-Moriya interaction, Zeeman coupling, and thermal noise. We show that, under an applied perpendicular magnetic field, increasing temperature can drive the system away from a uniformly magnetised state toward a regime in which skyrmions spontaneously appear as thermally activated topological excitations. Once formed, these textures exhibit fluctuating particle-like dynamics and finite lifetimes, eventually disappearing through thermally activated annihilation. At the same time, thermal fluctuations can also give rise to new nucleation events, leading to a dynamic balance between creation and annihilation processes.

[1] Wang, J., Strungaru, M., Ruta, S., Meo, A., Zhou, Y., Deák, A., ... & Chantrell, R. W. (2021). Spontaneous creation and annihilation dynamics of magnetic skyrmions at elevated temperature. *Physical Review B*, 104(5), 054420.

[2] Evans, R. F., Fan, W. J., Chureemart, P., Ostler, T. A., Ellis, M. O., & Chantrell, R. W. (2014). Atomistic spin model simulations of magnetic nanomaterials. *Journal of Physics: Condensed Matter*, 26(10), 103202.

Presenter

 **Sergiu RUTA**






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Session Information

-  **Location:** Room P7
-  **Day:** 2 - Tuesday 16th
-  **Time:** 08:45-09:00
-  **Chairperson:** N/A
-  **Presentation Type:** Poster presentation

Synthetic magnetic field for dark state ultracold atoms

Abstract

The quantum-mechanical motion of a charged particle in a homogeneous magnetic field is characterized by degenerate Landau levels, which play an essential role in the integer and fractional Quantum Hall effects and their underlying topological properties [1]. This degeneracy generally disappears when the magnetic field becomes inhomogeneous. However, Aharonov and Casher showed that for electrons with spin aligned along the magnetic field the ground state remains degenerate even in a non-homogeneous magnetic field [2]. Recently, similar situations have been identified in the adiabatic motion of quantum particles, such as valence band holes in bilayer systems [3] and ultracold atoms dressed by laser fields [4,5]. In these systems, geometric scalar and vector potentials give rise to an effective magnetic field with nontrivial geometric and topological structure. By properly choosing system parameters, this field can satisfy the Aharonov–Casher (AC) condition [3,4], preserving the degeneracy of the lowest Landau level and enabling the realization of topologically protected states, which is important for simulating the fractional Quantum Hall effect.

In this work, we provide a general framework for achieving the AC condition for the adiabatic motion of dark-state atoms in the Λ -type atom–light coupling scheme. This is accomplished by constructing the laser fields from properly chosen superpositions of plane waves. We further analyze configurations involving three, four, and six symmetrically distributed plane waves, as well as quasicrystalline structures formed by five waves. Small deviations from perfect tuning produce narrow subwavelength peaks of strong magnetic field and scalar potential, compensated by a smooth background field of opposite sign, resulting in zero total flux per unit cell. As these peaks are sufficiently narrow, their influence is minimal, and the lowest Landau level remains nearly flat while retaining its topological character.

- [1] Zyun F. Ezawa. QUANTUM HALL EFFECTS. Number 0. WORLD SCIENTIFIC, 2026/02/06 2011.
- [2] Y. Aharonov and A. Casher. Ground state of a spin-charged particle in a two-dimensional magnetic field. *Phys. Rev. A*, 19:2461–2462, Jun 1979.
- [3] Jingtian Shi, Nicolás Morales-Durán, Eslam Khalaf, and A. H. MacDonald. Adiabatic approximation and aharonov-casher bands in twisted homobilayer transition metal dichalcogenides. *Phys. Rev. B*, 110:035130, Jul 2024.
- [4] Ophelia Evelyn Sommer and Nigel R. Cooper. Ideal optical flux lattices, 2025.
- [5] D. Burba and G. Juzeliūnas. Two dimensional sub-wavelength topological dark state lattices. *Phys. Rev. Research* 7, 043090, 2025.

 **Presenter**

 **Dominykas BORODINAS**

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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 08:45-09:00

 **Chairperson:** N/A

 **Presentation Type:** Poster presentation

Topological sub-wavelength optical lattices for ultracold atoms

Abstract

Ultracold atoms provide a versatile platform for simulating topological and many-body phenomena in condensed matter and high-energy physics [1-4]. The use of atomic dark states (long-lived superpositions of atomic internal ground states immune to atom-light coupling) offers new possibilities for such simulations. Making the dark states position-dependent allows for the generation of a synthetic magnetic field for ultracold atoms, as they adiabatically follow the dark states [5-7]. This enables the emulation of the Quantum and Fractional Hall effects. Here, we present a general description of two-dimensional (2D) topological dark-state lattices, elucidating their interplay with sub-wavelength lattices [7]. In particular, we demonstrate that one can create a 2D Kronig-Penney lattice representing a periodic set of 2D subwavelength potential peaks affected by a non-staggered magnetic flux. Away from these patches of the strong magnetic field, there is a smooth background magnetic flux of the opposite sign, compensating for the former peaks. For sufficiently narrow regions of the strong magnetic field, the smooth background magnetic field dominates, leading to various topological phenomena. This work paves the way for experimental exploration of topological phases in dark-state optical lattices, offering new possibilities for simulating quantum Hall systems, fractional Chern insulators and related strongly correlated phases.

- [1] M. Lewenstein et al, *Adv. Phys.* 56, 243 (2007).
- [2] I. Bloch, J. Dalibard, and W. Zwerger, *Rev. Mod. Phys.* 80, 885 (2008).
- [3] C. Gross and I. Bloch, *Science* 357, 995 (2017).
- [4] N. Goldman, G. Juzeliūnas, P. Öhberg, and I. B. Spielman, *Rep. Prog. Phys.*, 77, 126401 (2014).
- [5] E. Gvozdiovas, I. B. Spielman, and G. Juzeliūnas, *Phys. Rev. A*, 107, 033328 (2023).
- [6] S. Nascimbene and J. Dalibard, *Phys. Rev. Lett.* 135, 153402 (2025).
- [7] D. Burba and G. Juzeliūnas, *Phys. Rev. Research* 7, 043090 (2025).

Presenter

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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 09:00-10:00

 **Chairperson:** Teodora KIROVA

 **Presentation Type:** Oral presentation

Realizing Integer and Fractional Quantum Hall states with a few rapidly rotating Fermions

Abstract

The fractional quantum Hall (FQH) effect exhibits remarkable states that due to strong correlations and topological nature host exotic properties such as fractionally charged quasi-particles and anyonic exchange statistics. Realizing these states in scalable engineered systems holds great potential for deepening our understanding of their microscopic origins, yet it remains a challenge. One fundamental class of FQH states is represented by the celebrated Laughlin wavefunction, which describes a strongly correlated state in which the interaction energy is minimized by incorporating the relative angular momentum between all constituents.

Here we present the direct realisation of the two-particle Laughlin wavefunction by rapid rotation of two interacting spinful fermions in a tight optical tweezer [1]. We owe this result to our newly established experimental tools allowing us to precisely shape and modulate our optical potentials using coherently interfering laser fields [2]. Using a single atom and spin resolved imaging technique we sample the Laughlin wavefunction and reveal its distinctive features: a ground state distribution in the center-of-mass motion, a vortex distribution in the relative motion, correlations in the relative angle of the two particles, and the suppression of inter-particle interactions.

Building on this technique, we show recent results on larger systems: we realize a two-component integer quantum Hall (IQH) state comprising 3+3 spinful fermions and observe a hallmark feature of IQH states – a uniform flattening of the density distribution. Together with the tunability of interactions, this brings within experimental reach the atom-by-atom assembly of larger FQH states and the observation of a precursor of a quantum phase transition between IQH states of weakly interacting fermions and FQH states of interacting bosonic molecules.

[1] P. Lunt, P. Hill, J. Reiter, P. M. Preiss, M. Gałka, and S. Jochim, Realization of a Laughlin State of Two Rapidly Rotating Fermions, *Phys. Rev. Lett.* 133, 253401 (2024)

[2] P. Lunt, P. Hill, J. Reiter, P. M. Preiss, M. Gałka, and S. Jochim, Engineering single-atom angular momentum eigenstates in an optical tweezer, *Phys. Rev. A* 110, 063315 (2024)

Presenter

 **Maciej GAŁKA**






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Session Information

-  **Location:** Room P7
-  **Day:** 2 - Tuesday 16th
-  **Time:** 10:30-11:30
-  **Chairperson:** Teodora KIROVA
-  **Presentation Type:** Oral presentation

Superconductivity in curved 3D nanoarchitectures

Abstract

In recent years, superconductivity and vortex matter in curved 3D nanoarchitectures have turned into a vibrant research avenue because of the rich physics of the emerging geometry- and topology-induced phenomena and their prospects for applications in (electro)magnetic field sensing and information technology. While this research domain is still in its infancy, numerous theoretical predictions await their experimental examination. In my talk, after a brief introduction to the topical area [1], I will outline experimental techniques capable of fabrication of curved 3D nanostructures and review selected recent results on the intertwined dynamics of Meissner currents, Abrikosov vortices, and slips of the phase of the superconducting order parameter therein [2]. I will share our vision regarding prospect directions and current challenges in this research domain, arguing that curved 3D nanoarchitectures open up a direction in superconductors' research and possess great potential for magnetic field sensing, bolometry, and fluxonic devices.

[1] V. Fomin and O. Dobrovolskiy, A Perspective on superconductivity in curved 3D nanoarchitectures, Appl. Phys. Lett. 120 (2022) 090501.

[2] O. Dobrovolskiy, O. Pylypovskyi, L. Skoric, A. Fernandez-Pacheco, A. Van Den Berg, and S. Ladak, Complex-Shaped 3D Nanoarchitectures for Magnetism and Superconductivity in "Curvilinear Micromagnetism: From Fundamentals to Applications" (eds.) D. Makarov and D. Sheka, Springer, 2022, chap. 5, pp. 215–268, ISBN 978-3-031-09085-1

Presenter

 **Oleksandr DOBROVOLSKIY**

 Technische Universität Braunschweig

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Authors

1. DOBROVOLSKIY, Oleksandr — Cryogenic Quantum Electronics, EMG and LENA, Technische Universität Braunschweig

Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 11:30-11:50

 **Chairperson:** Teodora KIROVA

 **Presentation Type:** Oral presentation

Detection of spin polarized currents by spin-torque skyrmion resonance in a frustrated magnet

Abstract

The frustrated Fe₃Sn₂ magnet is technologically attractive due to its extreme-temperature skyrmion stability, large topological Hall effect, and current-induced helicity switching attributed to a self-induced spin-torque. Here [1], we present a current-driven skyrmion resonance technique excited by self-induced spin-torque in Fe₃Sn₂. The dynamics are probed optically in a time-resolved measurement enabling us to distinguish between the excited modes. We find that only the breathing and rotational counterclockwise modes are excited, rather than the three modes typically observed in Dzyaloshinskii-Moriya interaction-dominated magnetic textures. When a DC current is passed through the crystal, the skyrmion resonance linewidth is modulated. Our micromagnetic simulations indicate that the linewidth broadening arises from an effective damping-like spin-orbit torque. Accordingly, we extract an effective spin Hall conductivity of $793 \pm 176 (\hbar/e) (\Omega \text{ cm})^{-1}$. Complementary planar Hall measurements suggest a small yet finite contribution of the real-space spin texture in the electronic transport in addition to a primary k-space contribution. Our results bring new insights into the anisotropic nature of spin-torques in frustrated magnets and to the possibility of using the skyrmion resonance as a sensor for spin currents.

[1] N. Bernstein et al., Nature Communications, 16, 4616 (2025)

Presenter

 Amir CAPUA

 The Hebrew University of Jerusalem


 Israel


Authors

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Session Information

 Location: Room P7

 Day: 2 - Tuesday 16th

 Time: 11:50-12:10

 Chairperson: Teodora KIROVA

 Presentation Type: Oral presentation

Magnetic skyrmions probed and manipulated by spin-polarized scanning tunneling microscopy: Efficient spin switching

Abstract

Spin-polarized scanning tunneling microscopy (SP-STM) is a very useful tool to obtain atomic-scale information on real-space complex spin textures at material surfaces [1,2]. Moreover, by locally applying current pulses with the SP-STM tip the controlled manipulation of individual magnetic skyrmions have been demonstrated [3]. The effect of the spin transfer torque (STT) of the tunneling electrons [4] responsible for the magnetic switching and manipulation of magnetic skyrmions is analyzed. For our theoretical investigation metastable skyrmionic spin structures with various topological charges ranging from $Q = -3$ to $+2$ in the (Pt_{0.95}Ir_{0.05})/Fe/Pd(111) ultrathin magnetic film are considered. We find that the STT efficiency (torque/current) acting on the spins of the skyrmions can reach large values up to 25 million meV/A, but they dramatically vary between large and small values depending on the lateral position of the SP-STM tip above the topological spin textures [5]. A simple expression for the STT efficiency is introduced to explain its variation. Our results are expected to guide SP-STM experiments to select SP-STM tip positions for an efficient switching of the skyrmionic structures by localized tunneling STT. Furthermore, our calculated spin transport vectors can be used for the investigation of tunneling-current-induced spin dynamics of topologically distinct surface magnetic skyrmionic textures.

References:

- [1] N. Romming et al. Phys. Rev. Lett. 114, 177203 (2015).
- [2] K. Palotás et al. Phys. Rev. B 96, 024410 (2017).
- [3] N. Romming et al. Science 341, 636 (2013).
- [4] K. Palotás et al. Phys. Rev. B 97, 174402 (2018). K. Palotás, Phys. Rev. B 98, 094409 (2018).
- [5] K. Palotás et al. J. Magn. Magn. Mater. 519, 167440 (2021).

Presenter

Krisztián PALOTÁS

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 **Session Information**

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 12:10-12:30

 **Chairperson:** Teodora KIROVA

 **Presentation Type:** Oral presentation

Topology and critical properties of divergenceless ferroic textures

Abstract

In nanoscale ferroic materials, the order parameter is often subject to local constraints that restrict its allowed configurations. For example, electrostatic interactions enforce a charge-neutrality condition on the electric polarization P , $\nabla \cdot P = 0$, which prevents polarization streamlines from beginning or ending inside the ferroelectric material [1]. This divergenceless constraint provides a natural topological framework for understanding the complex polarization patterns, such as polar vortices and hopfions, observed in nanoscale ferroelectrics. Remarkably, it also drives the system to a distinct universality class with strongly enhanced fluctuations and an unusually large anomalous dimension, demonstrating that topology alone can reshape critical behavior in otherwise conventional ferroic systems [2].

[1] I. A. Lukyanchuk, A. G. Razumnaya, S. Kondovych, et al., Phys. Rep. 1110, 1 (2025).

[2] S. Kondovych, A. Sudbø, and F. S. Nogueira, Phys. Rev. Research 8, 013186 (2026).

Presenter

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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 14:30-15:30

 **Chairperson:** Dennis MEIER

 **Presentation Type:** Oral presentation

Tuning Polar Textures with Temperature Gradients

Abstract

Materials containing local dipole moments, such as ferroelectrics, are emerging as a new arena in which to explore topological textures. In analogy to magnetic materials, ferroelectrics can host domain walls, vortices, skyrmions and a plethora of other textures. These exotic phases can be created via epitaxial or superlattice engineering, and their properties tuned with external perturbations such as strain or electric fields.

A gradient in the temperature of a ferroelectric system is also a very powerful tool to engineer bespoke properties and textures in ferroelectrics. Using second-principles molecular dynamics, we show how a modulation in the temperature can lead to direct control of the orientation of electric dipoles. We then reveal how more complicated textures be created through appropriate application of temperature gradients.

Presenter

 **Cameron SCOTT**

 Luxembourg Institute Of Science


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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 15:30-16:30

 **Chairperson:** Dennis MEIER

 **Presentation Type:** Oral presentation

Chasing topological texture in polar oxides

Abstract

Topological polarization textures in polar oxides are attracting increasing attention as potential building blocks for next-generation nanoelectronics devices. This contribution presents an overview of recent progress in the modeling and understanding of skyrmionic defects in ferroelectric materials. We discuss computational approaches for stabilizing, identifying, and characterizing these topological structures, using atomistic simulations based on potentials fitted from first-principles calculations.

These methods have enabled the prediction of polar skyrmions and antiskyrmions and reveal that their stabilization can be achieved through suitable nanodomain configurations, such as columnar domains with polarization opposite to the surrounding matrix. The interaction of topological polarization textures with external electric fields is also addressed, as a route to create and move such textures.

Finally, emerging perspectives for the design and control of ferroelectric skyrmions are discussed, including opportunities offered by strain engineering and chemical doping strategies.

Presenter

 **Mauro António PEREIRA GONÇALVES**

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Session Information

 **Location:** Room P7

 **Day:** 2 - Tuesday 16th

 **Time:** 17:00-18:00

 **Chairperson:** Dennis MEIER

 **Presentation Type:** Oral presentation

Spatial Distribution of an Excitation along Biomolecular Chains and Their Geometrical Topology

Abstract


Biomolecular chains play a crucial role in biochemical processes in living cells. Their functionality depends on multiple factors, including structural composition and chain geometry. Additionally, various types of excitations (e.g., electronic, vibronic,..) can alter the local distribution of charge density and electric dipole moments along the chain, thereby affecting the activity of the molecule's active centre or the biomolecule as a whole. Due to quantum resonance effects, such excitations can form delocalized quantum states, which may induce changes at active centres distant from the initially excited node.

Chain geometry and topology strongly influence these states. Excitation behavior in a linear chain differs substantially from that in a cyclic (closed) structure. Particularly interesting are states formed in structures with nodal points, where the chain intersects itself. Depending on the position of the initially excited node, different states may emerge. These include states where the probability of finding the excitation is distributed over multiple regions of the structure, and those where it is significant only in a limited part of the chain while being practically absent elsewhere.

In our numerical study, we investigated the effect of chain topology on the spatial distribution of a single excitation along a closed chain with one intersection point dividing it into unequal parts. Three scenarios were considered: (1) excitation at the intersection point, (2) at the midpoint of a loop, and (3) at an arbitrary loop position. Results show that the position of the initially excited node strongly affects the excitation distribution. Comparisons with linear and cyclic chains without intersections highlight the role of geometrical topology. These findings suggest that applying mathematical topology principles could provide a more general understanding of excitation behaviour in complex biomolecular structures.

Presenter

Dalibor CHEVIZOVICH

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Session Information

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 08:50-09:00

 **Chairperson:** N/A

 **Presentation Type:** Poster presentation

Interaction and collision of skyrmions in chiral antiferromagnets

Abstract

Skyrmions in an antiferromagnet can travel as solitary waves in stark contrast to the situation in ferromagnets. Traveling skyrmion solutions have been found numerically in chiral antiferromagnets. We study head-on collision events between two skyrmions. We find that the result of the collision depends on the initial velocity of the skyrmions. For small velocities, the skyrmions shrink as they approach, then bounce back and eventually acquire almost their initial speed. For larger velocities, the skyrmions approach each other and shrink until they become singular points at some finite separation and are eventually annihilated. Considering skyrmion energetics, we can determine the regimes of the different dynamical behaviors. Using a collective co-ordinate approach, we reproduce the dynamics of the collisions including the variation of the size of the skyrmions and collapse above a critical velocity.

Presenter

 **George THEODOROU**

 University of Crete

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Session Information

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 08:50-09:00

 **Chairperson:** N/A

 **Presentation Type:** Poster presentation

Nonlinear Optical Imaging of Polar Topological Textures in Ferroelectric Materials

Abstract

The emergence of topological polarization textures in ferroelectric materials is reshaping our understanding of ferroic order, extending it beyond uniform states toward complex, spatially structured configurations. Non-Ising and chiral domain walls, bubble domains, (anti)vortices, and polar (anti)skyrmions illustrate how symmetry breaking, electrostatic boundary conditions, and reduced dimensionality give rise to rich polarization landscapes with functional potential.

A central challenge in this context is the development of imaging approaches capable of resolving such polarization textures in three dimensions, while preserving sensitivity to symmetry and chirality. Second-harmonic generation (SHG) microscopy provides a powerful platform in this regard, owing to its intrinsic sensitivity to broken inversion symmetry and polarization orientation [1]. In particular, SHG polarimetry enables the reconstruction of complex polar states [2,3] and the discrimination between different polar topological structures such as chiral Bloch walls, non-Ising Néel walls, and Bloch lines [4].

In this talk, I will present recent advances in SHG-based imaging of polar topological textures, combining polarimetric measurements with machine-learning-assisted analysis [5,6] to achieve rapid and quantitative 3D mapping of polarization fields. I will further show how circular dichroism in SHG (CD-SHG) can be harnessed to probe chiral ferroic states. The developed polarimetry and symmetry analysis framework establish SHG microscopy and CD-SHG, as reliable approaches for imaging and characterization of polar topological textures. It contributes to the broader effort of defining and probing complex ferroic states, and provides a general framework for nonlinear optical studies of ferroic order in anisotropic materials.

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 **Presenter**

 **Salia CHERIFI-HERTEL**

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 **Session Information**

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 09:00-10:00

 **Chairperson:** Paul GAVRILOAEA

 **Presentation Type:** Oral presentation

Novel Topological Structures at Twisted Ferroelectric Interfaces

Abstract

We have been examining the combined effect of polar discontinuities and crystallographic twist on the properties of bonded ferroelectric interfaces (specifically lithium niobate). Two interesting observations have been made: firstly, that emergent 2D conductivity can be shut down at specific twist angles at which there is a sparsity in the interfacial coincident lattice. secondly, that interfacial nanoscale arrays of structural and dipolar helices emerge with distinct chiral properties. While such structures might be expected from twist alone, it seems that the intensity of their dichroic response is dramatically enhanced because of the polar discontinuity.

Presenter

 **Marty GREGG**

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Session Information

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 10:30-11:30

 **Chairperson:** Paul GAVRILOAEA

 **Presentation Type:** Oral presentation

Topological spin textures in 2D magnets

Abstract

Topological spin textures in two-dimensional magnets have emerged as a promising route toward nanoscale information storage and ultrafast spintronic functionality. In particular, light-driven control of magnetic order offers an appealing strategy for creating and manipulating nontrivial spin configurations on femtosecond to picosecond timescales. This work focuses on the generation of topological spin textures in the 2D van der Waals magnets, CrCl_3 and Fe_3GeTe_2 . Using atomistic spin dynamics combined with a two-temperature model of laser-induced heating, our study demonstrates that optical pulses can drive the magnetic system out-of-equilibrium and induce vortex-like magnetic textures, such as merons and antimerons. These structures are identified by computing the topological number and arise in CrCl_3 without Dzyaloshinskii–Moriya interactions. Beyond their formation, the laser-induced textures display rich dynamical behavior, including vortex–antivortex creation, motion and annihilation, all of which contribute to abrupt changes in the total topological number.

We also consider Fe_3GeTe_2 , an out-of-plane van der Waals ferromagnet for the study of nontrivial magnetic textures such as skyrmions, stabilised by Dzyaloshinskii–Moriya interactions. Its strong perpendicular magnetic anisotropy, relatively high Curie temperature compared with many other 2D magnets and metallic character make it especially attractive for spintronic applications. These properties can favour the stabilisation, electrical detection, and possible manipulation of skyrmion-like states, while also enabling stronger coupling between magnetic textures and charge transport. Our findings position 2D magnets as attractive platforms for exploring light-controlled topological spin phenomena and for developing future low-power, ultrafast devices based on nanoscale magnetic textures.

References:

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- [4] Wang, Junlin, et al. *Physical Review B* 104.5 (2021): 054420.

Presenter

 **Mara STRUNGARU**

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Session Information

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 11:30-12:30

 **Chairperson:** Paul GAVRILOAEA

 **Presentation Type:** Oral presentation

Novel three-dimensional topological magnetic domain walls and their dynamics


Abstract

Three-dimensional magnetism promotes a rich complexity of magnetization configurations and domain wall types that are chiral and topologically non-trivial. Examples of these domain walls are Bloch point (BP) or vortex-antivortex (VAV) domain walls (DWs) in 3D nanowires with longitudinal magnetization. Even more complex DWs can exist in nanowires with circular magnetisation. For development of 3D nanotechnologies, it is important to understand the possibility to efficiently manipulate these DWs by external stimuli. Here we discuss from theoretical and modelling perspective their dynamics under external field, current and temperature gradient. The first important characteristic is that only the BP DW is a fast object. However, it is characterized by a complex gyrovectore that does not allow its straight motion [1], it goes to the nanowire surface and the known topological transformations from one domain wall to the other may occur [1-4]. Secondly, the shape of this DW is dynamically deformed acquiring the conical shape under the application of the field [3] or butterfly-like shape under the action of current and Oersted field [4]. At the same time, large BP DW velocities, more than 10km/s can be achieved under the action of the field due to the jet-propulsion effect [3]. On the other hand, the VAV DWs are stable but very slow objects, rarely exceeding velocities of 10m/s. Their dynamics is quite complex and they experience a rotational and re-coiling effects [5]. 3D domain walls can also be moved by thermal gradients due to entropic torques [6]. However, they are quite stable and large gradients are necessary to initiate the dynamics. The VAV DW requires smaller gradients than the BP DW.

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- [7] D.Altbir et al Sci. Rep. 10, 21911 (2020).

 **Presenter**

 **Oksana CHUBYKALO-FESENKO**






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Session Information

-  **Location:** Room P7
-  **Day:** 3 - Wednesday 17th
-  **Time:** 14:30-14:50
-  **Chairperson:** Krisztián PALOTÁS
-  **Presentation Type:** Oral presentation

Spin Inertia as a Source of Topological Magnons: Chiral Edge States from Coupled Precession and Nutation

Abstract

Spin inertia has been demonstrated to give rise to high-frequency nutational excitations beyond the conventional low-frequency precessional modes. Here, we demonstrate that the hybridization between precessional and nutational magnons may give rise to topological phenomena in the spin-wave spectrum. This hybridization requires the presence of interactions breaking angular-momentum conservation, such as the pseudodipolar interaction. We show on the example of a honeycomb ferromagnet how topological gaps open between the precessional and nutational bands that host chiral edge states in slab geometries. Our work establishes a theoretical foundation for exploring inertial spin dynamics as a new route to engineer topological phases in magnetic materials.

Presenter

Levente RÓZSA

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Session Information

 **Location:** Room P7

 **Day:** 3 - Wednesday 17th

 **Time:** 14:50-15:10

 **Chairperson:** Krisztián PALOTÁS

 **Presentation Type:** Oral presentation

Dynamics of skyrmions in magnets and a memory effect

Abstract

Topological solitons, such as skyrmion, in ferromagnets are known to be spontaneously pinned in the absence of an external force. When subjected to a force, such as a magnetic field gradient, they are deflected perpendicular to the applied force, resulting in dynamics that differ fundamentally from those of Newtonian particles. This behaviour is captured by the special conservation laws associated with linear momentum in ferromagnets.

In antiferromagnets, by contrast, solitons can propagate freely in the absence of external forces and follow Newtonian and relativistic dynamics. We find that chiral skyrmions increase in size as their velocity increases, in contrast to the behaviour expected in Lorentz-invariant models.

Skyrmions in synthetic antiferromagnets (two antiferromagnetically coupled ferromagnetic layers) initially behave similarly to ferromagnetic skyrmions under a magnetic field gradient, that is, the skyrmions in both layers move almost perpendicular to the field gradient. However, this motion is eventually halted leaving the two skyrmions separated by a finite distance. We find numerically that, below a critical magnetic field gradient strength, the system displays an unusual "memory" effect: when the magnetic field gradient is removed, the skyrmions return to their original positions with high accuracy. We explain this phenomenon using a moduli-space approximation for the dynamics. Furthermore, we provide an exact treatment of the dynamics, demonstrating that small deviations from perfect positional memory can occur.

Presenter

 **Stavros KOMINEAS**

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 09:00-10:00

 **Chairperson:** Michele RUGGERI

 **Presentation Type:** Oral presentation

Magnetic skyrmions

Abstract

TBD

Presenter

 **Theresa SIMON**

 University of Münster

 Germany

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 10:30-11:30

 **Chairperson:** Michele RUGGERI

 **Presentation Type:** Oral presentation

A variational approach to ferronematics with a stray field energy

Abstract

Ferronematic materials are colloidal suspensions of magnetic particles in liquid crystals. They are complex materials with potential applications in display technologies, sensors, microfluidics devices, etc. We consider a model for ferronematics in a 2D domain with a variational approach. The proposed free energy of the ferronematic system depends on the Landau-de Gennes (LdG) order parameter Q and the magnetization M , and incorporates the complex interaction between the liquid crystal molecules and the magnetic particles in the presence of an external magnetic field H_{ext} . The energy functional combines the Landau-de Gennes nematic energy density and energy densities from the theory of micromagnetics including (an approximation of) the stray field energy and energetic contributions from an external magnetic field. For the proposed ferronematic energy, we first prove the existence of an energy minimizer and then the uniqueness of the minimizer in certain parameter regimes. Secondly, we numerically compute stable ferronematic equilibria by solving the gradient flow equations associated with the proposed ferronematic energy. The numerical results show that the stray field influences the localization of the interior nematic defects and magnetic vortices.

Presenter

 **Shilpa DUTTA**

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 11:30-11:50

 **Chairperson:** Michele RUGGERI

 **Presentation Type:** Oral presentation

Construction of Novel Algebra

Abstract

The Poisson geometry of a discrete string in three dimensional Euclidean space is investigated. For this the Frenet frames are converted into a spinorial representation, the discrete spinor Frenet equation is interpreted in terms of a transfer matrix formalism, and Poisson brackets are introduced in terms of the spinor components.

Presenter

 **Theodora IOANNIDOU**

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 11:50-12:10

 **Chairperson:** Michele RUGGERI

 **Presentation Type:** Oral presentation

Phonons scattering off discrete asymmetric solitons in the absence of a Peierls–Nabarro potential

Abstract

We analyze the interaction of lattice vibrations (phonon wave-packets) with an asymmetric kink soliton initially at rest. We employ the ϕ^6 model in one space and one time dimensions for various lattice spacings and consider two different discretization prescriptions for the field potential that do not generate Peierls–Nabarro potentials, i.e. the kink can be placed anywhere along the lattice beyond discrete translational invariance. Since the ϕ^6 model kink is neither symmetric nor antisymmetric under spatial reflections, we simulate the cases where the wave-packet approaches the kink from negative or positive spatial infinity. We extract the energy transmission and reflection coefficients as functions of the central frequency of the phonon wave-packet for the different lattice spacings. For large lattice spacings, the wave-packet is always fully reflected, while for smaller spacings the amount of reflection and transmission depends on the central frequency. We also identify scenarios in which the target kink acquires a non-zero velocity from its interaction with the wave-packet.

Presenter

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 12:10-12:30

 **Chairperson:** Michele RUGGERI

 **Presentation Type:** Oral presentation

Participation in Science Is Designed: What Shapes Inclusion, Visibility, and Engagement in Research Communities

Abstract

Participation in science is often presented as open, merit-based, and equally accessible to everyone. However, the structures through which scientific research is organised significantly influence who can participate, whose work gains visibility, and who feels acknowledged within academic and research communities. In *Greek Women in STEM*, we address issues surrounding participation in science with the aim of drawing attention to and reshaping the infrastructures that hinder inclusion.

In this presentation, through a socio-technical approach, we will focus on the systems, practices, and infrastructures that affect inclusion, visibility, and engagement in research environments. Drawing from perspectives in science and technology studies, we will illustrate how institutional norms and structures, conference spaces, and digital platforms contribute to experiences of participation in STEM.

While scientific communities are often imagined as neutral spaces governed primarily by expertise and achievement, in reality, participation is shaped by many invisible dynamics, including access to networks, representation, recognition, platform visibility, and informal social practices. Such dynamics can significantly affect how researchers navigate academic spaces and maintain long-term engagement in scientific communities.

Participation, therefore, is not merely an individual choice or a result of personal motivation. It is continuously shaped and negotiated through the environments and systems in which research takes place. By reframing participation as something intentionally designed rather than a naturally occurring phenomenon, this talk will spark a broader discussion about responsibility and design in scientific communities. What kinds of academic cultures foster a sense of belonging? Which practices support sustained engagement and visibility for diverse researchers? How can institutions and networks move beyond symbolic inclusion towards meaningful participation?

Through this discussion, our presentation emphasises the significance of creating equitable and reflexive research cultures that view diversity not as an afterthought but as central to scientific collaboration and innovation. Ultimately, we argue that building inclusive scientific communities requires attention not only to who is present but also to how participation itself is structured, valued, and supported across the research ecosystem.

Presenter

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 **Session Information**

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 14:30-14:50

 **Chairperson:** Ionel Dumitrel GHIBA

 **Presentation Type:** Oral presentation

Interlayer Interaction as a Mechanism for Engineering Topological Textures in Thin Films: From Meron Crystals to Induced Skyrmions

Abstract

Topological magnetic textures, including skyrmions and merons, are promising for next-generation spintronic applications due to their nanoscale dimensions, stability, and efficient current-driven dynamics. Although research has primarily focused on monolayer systems, synthetic antiferromagnetic (SAF) bilayers introduce an additional degree of freedom through interlayer exchange coupling (J).

Large-scale Monte Carlo simulations based on a discrete Heisenberg model, incorporating exchange, Dzyaloshinskii-Moriya interaction (DMI), and triaxial anisotropy, are used to systematically explore the magnetic texture space of SAF bilayers. The results demonstrate that interlayer interactions are a critical factor in stabilizing complex magnetic textures that remain unstable in isolated monolayers.

Three distinct regimes are identified, governed by the competition between the external magnetic field (H) and interlayer exchange coupling (J):

1. **Topological Phase Transformation:** At intermediate magnetic fields, a transition occurs in which monolayer skyrmion lattices are reconstructed into robust meron-antimeron crystals, driven by the energy minimization of vertical flux-closing patterns.

2-**Interlayer-Induced Topology:** In high-field regimes where the monolayer is purely field-polarized, the introduction of SAF coupling triggers the nucleation of stable skyrmion lattices by effectively screening the Zeeman energy.

3. **Anisotropy-Mediated Stability:** The energetic penalty associated with core polarization is analyzed, demonstrating how easy-plane anisotropy dictates the transition between meron and skyrmion characteristics.

Mapping phase stability through detailed energy decomposition and topological charge (Q) analysis provides a theoretical framework for designing layered magnetic heterostructures with tailored topological properties. These findings offer new insights into the control of magnetic textures in multicomponent thin films.

 **Presenter**

 **Ümit AKINCI**

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 15:10-15:30

 **Chairperson:** Ionel Dumitrel GHIBA

 **Presentation Type:** Oral presentation

On the long time behaviour of the stochastic Landau-Lifschitz-Gilbert equation.

Abstract

In this work, we discuss the existence of statistically stationary solutions to the Schrödinger Map Equation on a bounded interval with zero Neumann boundary conditions. The statistically stationary solutions are constructed by means of stationary solutions to the Stochastic Landau-Lifschitz-Gilbert equation. As a corollary, we obtain the existence of statistically stationary solutions to the Binormal Curvature Flow. The talk is based on joint works with M. Hofmanová (<https://www.tandfonline.com/doi/full/10.1080/03605302.2025.2584807>) and Mouhamadou Sy (<https://arxiv.org/abs/2508.03551>).

Presenter

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 15:30-16:30

 **Chairperson:** Ionel Dumitrel GHIBA

 **Presentation Type:** Oral presentation

Singular perturbations of manifold-valued maps: topological singularities and compactness results

Abstract

Some variational models for ordered media—such as the Ginzburg–Landau model of superconductivity and the Landau–de Gennes model of liquid crystals—are based on free-energy functionals that favour configurations taking values in a given “ground-state manifold”. In this talk, we consider a simplified functional with this structure and study a singular limit in which deviations from the ground-state manifold are heavily penalised. In this regime, topological obstructions carried by the manifold may lead to the formation of singularities, whose energy diverges in the limit. Nevertheless, under suitable assumptions it is sometimes possible to prove compactness results for minimisers and/or to give a variational characterisation of the singularities that arise in this limit. The talk is based on joint work with several coauthors, including Haotong Fu and Wei Wang (Univ. Beijing), as well as Le Van Phu Cuong (Univ. Heidelberg), and Ramon Oliver Bonafoux and Giandomenico Orlandi (Univ. Verona).

Presenter

 **Giacomo CANEVARI**

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Session Information

 **Location:** Room P7

 **Day:** 4 - Thursday 18th

 **Time:** 17:00-18:00

 **Chairperson:** Ionel Dumitrel GHIBA

 **Presentation Type:** Oral presentation

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