Pavol Jozef Šafárik University in Košice
Faculty of Science

Magnetic Cooling and Frustrated Magnetism

COOL MAG 2025

October 27th - 29th, 2025
Košice, Slovakia

Programme & Abstracts

Košice 2025

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Magnetic Cooling and Frustrated Magnetism
Book of Abstracts

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Conference Date and Location

The workshop will be held on October 27th – 29th, 2025 at Pavol Jozef Šafárik University, Jesenná 5, Košice, 040 01. It will take place on the first floor, in the Video Conference Room, No. SJ1S24.

Main conference topics:

1. Magnetocaloric effect
2. Quantum entanglement, computing and information
3. Highly frustrated magnetism
4. Magnetic phase transitions
5. Topological and other exotic quantum states
6. Disordered states and quantum spin liquids
7. Molecular magnetism and nanostructures
8. Quantum spin chains and two-dimensional lattices
9. Flat-band physics in two dimensions
10. Exactly solved lattice-statistical models
11. Graphene and other strongly correlated electron systems

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We would also like to thank Madame *Hawa Gary* for her kind assistance with the administrative arrangements of the conference.

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Sylvain Capponi	Laboratoire de Physique Théorique, Toulouse, France
Ross Harvey Colman	Charles University, Prague, Czech Republic
Siân Dutton	Cambridge University, Great Britain
Philipp Gegenwart	University of Augsburg, Augsburg, Germany
Oleg Petrenko	University of Warwick, Great Britain
Rudolf Römer	University of Warwick, Great Britain
Guy Trambly	CY Cergy Paris Université, France
Arnaud Ralko	University of Grenoble Alpes and CNRS, France
Peter Schüßler	kiutra GmbH, Munich, Germany
Stefan Süllow	Technische Universität Braunschweig, Germany
Alexander Wietek	Max Planck Institute, PKS, Dresden, Germany
Mike Zhitomirsky	PHELIQS, CEA Grenoble - Université Grenoble Alpes, France

COOLMAG'25 Programme / October 27, 2025, Monday

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10:10-10:30	O-01	Andrej Gendiar	Strong correlations within mean-field universality: Tensor Network studies
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11:35-12:10	I-04	Sylvain Capponi	Variational study of the magnetization plateaux in the spin-1/2 kagome Heisenberg antiferromagnet
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15:05-15:40	I-06	Siân Dutton	Gadolinium double perovskites for low-temperature magnetocaloric refrigeration
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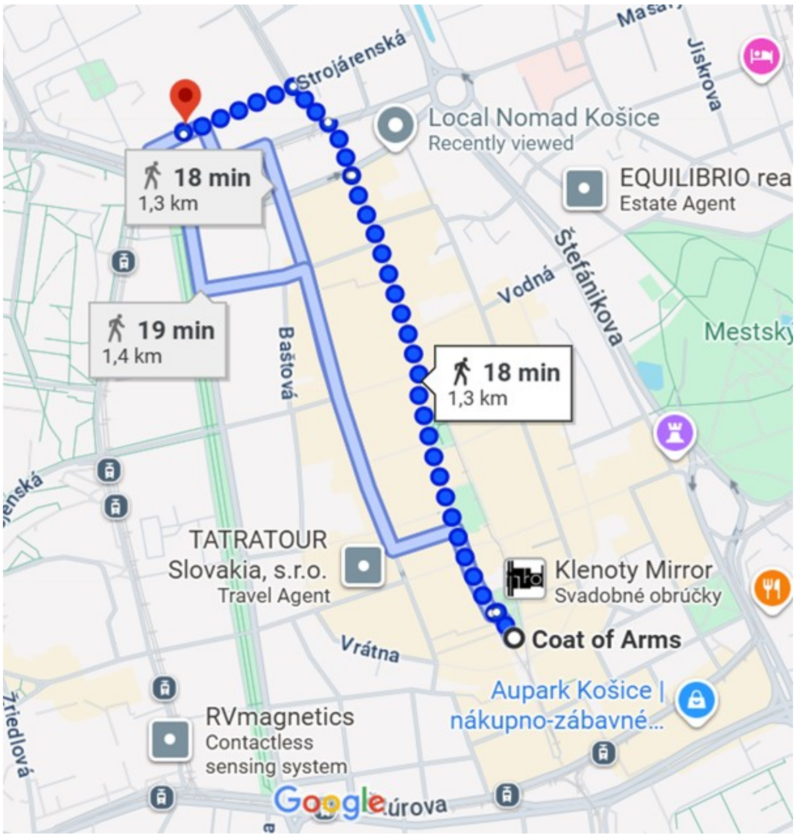
Guided City Tour – Košice

Tuesday, October 28, 2025
14:00 – 16:00

Meeting point with the guide (14:00): in front of the Košice Coat of Arms ("erb" monument on Hlavná Street) (`https://share.google/LAoql68ecuDB6iDXK`).

About the tour: A guided walk through Košice, discovering the city's history, architecture, and culture. Highlights include St. Elisabeth Cathedral, Jakab's Palace, the Jewish quarter, and stories from the 20th century up to modern days. More `https://localnomad.sk/booking/kosice-guided-city-tour/`.



Suggested walking route (Hotel Maraton → Košice Coat of Arms, meeting point).

Note: The guided city tour will take place *right after lunch*. We will **meet in front of Hotel Maraton at 13:30** and walk together to the meeting point. Those who prefer can join us directly at the **Košice Coat of Arms at 14:00**. Please allow about **20 minutes walking time** from the hotel to the meeting point. The guided city tour will last approximately **1.5–2 hours**, depending on the number of questions.

Participation is optional, but please be back by **17:00** when the conference programme continues.

Abstracts

One abstract per page

Invited lectures

(30 min. talk + 5 min. discussion)

I-01

27.10.2025 09:00–09:35

Advancing Finite-Temperature Dynamics with METTS: Complex-Time Correlators and Continuous-Temperature Sampling

Alexander Wietek*
Max Planck Institute for the Physics of Complex Systems

Abstract

Understanding the finite-temperature dynamics of strongly correlated quantum systems remains a central challenge in condensed matter physics. In this talk, we present a practical extension of the minimally entangled typical thermal states (METTS) framework for calculating dynamical correlators at nonzero temperatures. By employing complex-time evolution, our method significantly mitigates the growth of entanglement, enabling the study of larger system sizes and accessing real-time dynamics via analytic continuation or hermitian correlation functions. As an application, we showcase accurate results for the Shastry-Sutherland spin model, demonstrating the versatility of our approach.

In the second part of the talk, we introduce a novel extension of the METTS method that enables interpolation between different sampling temperatures, allowing for the generation of continuous-temperature data. This development opens up new possibilities for studying temperature-dependent phenomena with unprecedented precision, facilitating the construction of detailed phase diagrams and enhancing the interpretation of experimental and numerical results in quantum magnetism.

*Speaker: A. Wietek

I-02

27.10.2025 09:35–10:10

Utilizing frustration in Gd- and Yb-based oxides for efficient milli-Kelvin refrigeration

Philipp Gegenwart[1,*]

[1] University of Augsburg, Augsburg, Germany

Abstract

Accessing milli-Kelvin temperatures is a prerequisite for quantum-matter research and applications in quantum technologies. Adiabatic demagnetization refrigeration (ADR) is a simple and sustainable alternative to 3He/4He dilution refrigeration. Geometrically frustrated rare earth oxides feature important advantages compared to the traditionally utilized hydrated paramagnetic salts for mK-ADR, including higher entropy density, chemical stability and easier fabrication of cooling stages. I will present our recent work on materials optimization and customized ADR platforms for the Quantum Design Physical Property Measurement System.

Work in collaboration with Marvin Klinger, Jorginho Villar Guerrero, Anna Klinger, Paul Bittner, Tim Treu, Christian Heil, Anton Jesche, Arjun Unnikrishnan, Alexander Tsirlin, Yoshi Tokiwa and Kan Zhao. Financial support by the German Federal Ministry of Economic Affairs and Climate Action through project 03EFBY0321 and by the German Research Foundation (DFG) through Project 514162746 (GE 1640/11-1) is acknowledged.

Speaker: P. Gegenwart

I-03

27.10.2025 11:00–11:35

Quantum criticality and dimensional reduction in the sawtooth-chain compound atacamite $Cu_2Cl(OH)_3$

Süllow Stefan[1,*], Heinze Leonie[1,2], Kotte Tommy[3], Rausch Roman[4], Karrasch Christoph[4]

[1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Braunschweig, Germany

[2] Jülich Center for Neutron Science, Forschungszentrum Jülich GmbH, Garching, Germany

[3] Hochfeld-Magnetlabor Dresden and Würzburg-Dresden Cluster of Excellence ct.qmat, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

[4] Institut für Mathematische Physik, TU Braunschweig, Braunschweig, Germany

Abstract

Recently, we have characterized atacamite $Cu_2Cl(OH)_3$ as a material realization of quantum sawtooth chains with weak interchain couplings [1]. Here, we present an extensive high-field study of this material by means of specific heat and ^{1}H nuclear magnetic resonance (NMR) spectroscopy experiments in continuous and pulsed magnetic fields up to 58 T [2]. From our data, we have mapped the entropy landscape for fields as high as 35 T and have identified a field-induced quantum critical point at 21.9(1) T for $H \| c$ axis. The quantum critical point separates field regions with and without magnetic order, evidenced by our thermodynamic and NMR study, but lies far below full saturation of the magnetization. Corroborated by numerical results using density-matrix renormalization group calculations, this behavior is associated with a dimensional reduction of the spin system: the sawtooth chain effectively decouples into an antiferromagnetic spin-1/2 chain (backbone of the sawtooth chain) in the presence of an exchange field produced by the remaining field-polarized spins. It thus represents a unique type of a field induced quantum state.

References

[1] L. Heinze et al., Phys. Rev. Lett. **126**, 207201 (2021)

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*Speaker: S. Süllow

I-04

27.10.2025 11:35–12:10

Variational study of the magnetization plateaux in the spin-1/2 kagome Heisenberg antiferromagnet

Sylvain Capponi[1,*], Fabien Alet[1], Andreas Raikos[1]
[1]Laboratoire de Physique Théorique, Université Toulouse III - Paul Sabatier, Centre National de la Recherche Scientifiquey

Abstract

The spin-1/2 kagome Heisenberg antiferromagnet is known to exhibit several nontrivial magnetization plateaux. We will review some recent experimental progress to measure these features, as well as theoretical proposals.
Our study aims at characterizing all these plateaux using state-of-the-art variational wavefunctions given as neural quantum states (NQS), which are quite powerful when studying frustrated quantum magnets.

*Speaker: S. Capponi

I-05

27.10.2025 14:30–15:05

Electronic and magnetic properties of flat bands in twisted bilayer graphene

Guy Trambly de Laissardière*
Laboratoire de Physique Théorique et Modélisation (LPTM), CY Cergy Paris Université, CNRS, Cergy-Pontoise, France

Abstract

The moiré pattern of the magic-angle twisted bilayer graphene leads to the localization of the low-energy electrons in the AA-stacked regions, as reflected by the presence of very flat bands at low energies [1-3] (for recent review see [4]). This reduction of the kinetic energy increases the importance of interactions, rendering bilayer systems much more susceptible to correlation effects. This has been demonstrated experimentally through the discovery of correlated insulators and superconductivity [5].

Here, we present theoretical studies [4] of the electronic structure and quantum transport properties of these flat bands. We consider the structural parameters that condition them, such as rotation angle, bias voltage, heterostrain, as well as possible. We also investigate the magnetic instabilities using a combination of real-space Hartree-Fock and mean-field theories, starting from a tight-binding description of the non-interacting bilayer systems, to which we add a local Hubbard interaction U to model the Coulomb repulsion between electrons [6,7]. Localised magnetic states emerge at half filling for values of the Coulomb interaction U that are significantly smaller than those required to render an isolated layer magnetic. Preliminary results on the effect of doping in the flat bands show a strong effect on the magnetic order, which may be quite similar to what M. Lucas has shown [7] for monolayer graphene when the Fermi level is close to the van Hove singularity.

References

[1] G. Trambly de Laissardière, D. Mayou, L. Magaud, Nano Lett. **10** (2010), 804
[2] R. Bistritzer, A. H. MacDonald, Proc. Natl. Acad. Sci. **108** (2011), 12233
[3] E. Suárez Morell, J. D. Correa, P. Vargas, M. Pacheco, Z. Barticevic, Phys. Rev. B **82** (2010) 121407(R)
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[5] Y. Cao et al., Nature **556** (2018) 43 ; Nature **556** (2018) 80
[6] V. Vahedi, R. Peters, A. Missaoui, A. Honecker, G. Trambly de Laissardière, SciPost Phys. **11** (2021), 083
[7] M. Lucas et al. at this conference (2025)

Speaker: G. Trambly de Laissardière

I-06

27.10.2025 15:05–15:40

Gadolinium double perovskites for low-temperature magnetocaloric refrigeration

Siân Dutton[1,*]
[1]University of Cambridge

Abstract

Rare earth double perovskites, A_2GdMO_6 (A=Ba,Sr,Ca, M=Sb, Nb), form a fcc lattice of magnetic Gd^{3+} ions. Magnetic measurements indicate they have weak magnetic interactions and the magnetocaloric effect is well described using a free-spin model of non-interacting spins. In this talk I will present our recent work on the mixed-metal $Ba_2GdNb_{1-x}Sb_xO_6$ solid solution. X-ray diffraction and neutron diffraction indicate that all Nb-containing materials undergo a series of structural phase transitions from high temperature cubic, to tetragonal and at the lowest temperatures monoclinic. I will discuss how this impacts the magnetic and magnetocaloric properties and discuss the origin of the structural distortion in Ba_2GdNbO_6.

[*] *Speaker: S. Dutton*

I-07

27.10.2025 16:30–17:05

Monte Carlo simulations of real magnetic materials

Mike Zhitomirsky*
Institut Recherche Interdisciplinaire de Grenoble (IRIG) CEA

Abstract

The recent progress on the application of Monte Carlo methods for studying realistic spin models will be described. We begin with proving rigourously a mapping of a quantum spin-S model to a classical model with spin vectors of length $\sqrt{S(S+1)}$. Using this mapping, the transition temperatures have been calculated and compared to the experimental values for the topical magnetic materials: the altermagnetic candidates MnF_2 and MnTe, Van der Waals magnets CrI_3, $MnPSe_3$, $FePSe_3$ and $FePS_3$, $CoPS_3$, CrSBr. We also apply this approach to study the magnetocaloric effect in gadolinium in the vicinity of the Curie tmeperature and compare theoretical predictions with experimental results available in literature.

Speaker: M. Zhitomirsky

I-08

28.10.2025 08:45–09:20

Commensurate-incommensurate transition without magnetic field: emergence of nematic Luttinger liquid in XXZ chain

Natalia Chepiga[1,*]
[1]Delft University of Technology, Netherlands

Abstract

I will present the zero-magnetization phase diagram of a spin-1/2 chain with competing ferro- and antiferromagnetic interactions. Using density matrix renormalization group (DMRG) simulations, we discover two successive commensurate-incommensurate transitions of the non-conformal Pokrovsky-Talapov universality class, occurring (even) at zero magnetic field. The first transition marks the condensation of bound pairs of magnons into a critical phase with central charge c = 2, emerging from a gapped period-4 phase. At the second transition, an incommensurate quadrupolar (or nematic) Luttinger liquid forms out of a gapped phase separation state, via the pairwise condensation of domain walls. I will argue that both transitions involve the same underlying incommensurate nematic Luttinger liquid, and that the c = 2 phase can be understood as a coexistence of a conventional (single-magnon type) and quadrupolar (two-magnon type) Luttinger liquids.

*Speaker: N. Chepiga

I-09

28.10.2025 09:20–09:55

Large out-of-equilibrium magnetocaloric effect in rare-earth zirconate pyrochlores

O. Benton[1], Y. Skourski[2], D. Gorbunov[2], A. Miyata[2], J. Wosnitza[2], S. Zherlitsyn[2], G. Balakrishnan[3], M. Ciomaga Hatnean[3,4], O. A. Petrenko[3,*]

[1]School of Physical and Chemical Sciences, Queen Mary University of London, UK
[2] Helmholtz-Zentrum Dresden-Rossendorf, Hochfeld-Magnetlabor Dresden, Germany
[3] Department of Physics, University of Warwick, UK
[4] PSI Center for Neutron and Muon Sciences, Paul Scherrer Institute, Switzerland

Abstract

We explore the magnetic properties of $Nd_2Zr_2O_7$ and $Pr_2Zr_2O_7$ single crystals subjected to pulsed magnetic fields up to 60 T using magnetisation and magnetocaloric effect (MCE) measurements, with initial temperatures ranging from 2 to 31 K. The MCE data exhibit pronounced and unconventional hysteresis loops in which the sample temperature increases during both the up-sweep and down-sweep of the field. In $Nd_2Zr_2O_7$, the MCE further displays a striking plateau in temperature as a function of time, followed by a rapid temperature rise that begins precisely at the maximum applied field, across pulses with differing peak field strengths. Magnetisation measurements reveal an inferred temperature of the magnetic subsystem that differs significantly from the directly measured sample temperature and exhibits opposite hysteresis: the temperature is higher on the up-sweep than the down-sweep, unlike the direct measurements. These observations indicate a breakdown of thermal equilibrium between magnetic and lattice degrees of freedom on the timescale of the pulse ($\sim 10^{-1}$ s). We interpret the results using a phenomenological model involving three thermally coupled subsystems – the magnetic ions, phonons, and a thermal reservoir – which accounts well for the behaviour of $Pr_2Zr_2O_7$. However, it fails to reproduce the plateau seen in $Nd_2Zr_2O_7$. Agreement with $Nd_2Zr_2O_7$ data is improved substantially if we allow the thermal coupling between magnetic and lattice subsystems to depend on the product $H\frac{dH}{dt}$. Our results reveal anomalously slow heat transfer between magnetic and lattice subsystems and point toward a novel mechanism for dynamically controlling heat flow in $Nd_2Zr_2O_7$ via the rate of magnetic field variation.

Speaker: O.A. Petrenko

I-10

28.10.2025 10:45–11:20

Even–odd effect on Chiral spin liquids in Kitaev systems

Arnaud Ralko[1,*], Jaime Merino[2]

[1] Institut Néel, Université Grenoble Alpes et CNRS, Grenoble, France
[2] Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, Spain

Abstract

We explore chiral spin-liquid phases in multilayer Kitaev systems, emphasizing how dimensionality and even–odd effects [1] shape their excitation spectra and topological properties. Using parton-based approaches benchmarked against exact methods, we identify how spin–orbit coupling, frustration, and interlayer interactions stabilize both gapless and gapped chiral regimes. As illustrations, we connect these results to the spin-1/2 and spin-1 Kitaev models [2,3], highlighting common mechanisms and distinctive features. Relevance to candidate materials such as α-$RuCl_3$ and Ni-based honeycomb magnets will also be discussed, along with experimentally accessible signatures of chirality and spin fractionalization.

References

[1] Physical Review B, 111, 085152 (2025)
[2] Physical Review Letters, 124, 217203 (2020)
[3] Physical Review B, 110, 134402 (2024)

*Speaker: A. Ralko

I-11

28.10.2025 11:40–12:15

Quantum storage with flat bands

Carlo Danieli[1], Jie Liu[2], Rudolf A. Römer[3,*], Rodrigo A. Vicencio[4]

[1]Institute for Complex Systems, National Research Council (ISC-CNR), Via dei Taurini 19, 00185 Rome, Italy

[2] College of Electronic Information and Physics, Central South University of Forestry and Technology, Changsha 410004, China

[3] Department of Physics, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, UK

[4] Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile, Santiago 8370448, Chile

Abstract

The realization of robust quantum storage devices relies on the ability to generate long-lived, spatially localized quantum states. In this work [1], we introduce a method for the targeted creation of compact excitations in flat-band lattices. By injecting radiation waves from the system's edge and applying a localized on-site potential at the desired storage position, we induce hybridization between compact localized states (CLSs) of the flat band and resonant dispersive plane waves. This hybridization enables the formation of spatially compact, stable excitations suitable for quantum memory applications. We experimentally validate this mechanism using photonic waveguide arrays, focusing on two representative geometries: the diamond chain and the one-dimensional Lieb ladder. Our approach [1] is broadly applicable to any platform supporting flat-band physics.

References

[1] arXiv: https://arxiv.org/abs/2508.01846

*Speaker: Rudolf A. Römer

I-12

28.10.2025 17:00–17:35

Heisenberg spins on a network of corner-sharing triangles in 2D and 3D. Finite-temperature properties

Oleg Derzhko*

[1]Yukhnovskii Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine (YICMP), Svientsitskii Street 1, 79011 L'viv, Ukraine

Abstract

The kagome/hyperkagome lattice is a triangular network of corner-sharing triangles in 2D/3D. Quantum spins S (S=$\frac{1}{2}, 1, \frac{3}{2}, \ldots$) placed on such lattices with the nearest-neighbor antiferromagnetic Heisenberg exchange interactions provide an excellent playground in the theory of magnetism of crystalline substance. Besides, there are real-life compounds, the magnetic properties of which can be described within the framework of these quantum spin-lattice models. A study of the finite-temperature properties of frustrated quantum spin systems, on the other hand, is notoriously difficult, mainly because the universal quantum Monte Carlo method is not applicable. Another universal method – a high-temperature series expansion technique – can yield required information if it is complimented by the so-called entropy-method interpolation [1-4]. Besides, numerics is restricted to rather small systems and may yield inconclusive results especially for three dimensions.

In my talk I plan to touch several problems concerning the quantum Heisenberg model on the kagome or hyperkagome lattice at finite temperatures [5-8]. My focus is on the temperature dependence of the specific heat $c(T)$ and the uniform susceptibility $\chi(T)$.

In two dimensions (kagome-lattice Heisenberg antiferromagnet), we examine the temperature dependence of c and χ for $S \geq 1$ [5]. An extra low-temperature feature (peak or shoulder) below the main peak in $c(T)$ for the $S = \frac{1}{2}$ case is debated for a couple of years, whereas in the classical limit $S \to \infty$ $c(T)$ exhibits only the main peak. Using the entropy-method calculations, we discuss how $c(T)$ varies as S grows.

In three dimensions (hyperkagome-lattice Heisenberg antiferromagnet), we examine $c(T)$ and $\chi(T)$ for the $S = \frac{1}{2}$ case [6,8] using the entropy-method calculations complemented by finite-size numerics. We observe some similarities of the properties for the kagome and hyperkagome lattices. With our findings for the specific heat we discuss [8] a hidden-energy-scale proposal of Refs. [9,10]. It is worthy noting that the hyperkagome-lattice $S = \frac{1}{2}$ Heisenberg ferromagnet is also interesting: Its Curie temperature is only about 0.33 [7]. Finally, the hyperkagome lattice supports flat bands, that allows for a localized-magnon approach for investigation of the low-temperature magnetothermodynamics.

This study appears as a result of long-lasting collaboration between the Ukrainian team (O. Derzhko, T. Krokhmalskii, T. Hutak, M. Parymuda) and the German researchers (J. Richter, J. Schnack, R. Rausch). This project is funded by the National Research Foundation of Ukraine (2023.03/0063, Frustrated quantum magnets under various external conditions).

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[5] T. Hutak *et al.*, in preparation.
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Speaker: O. Derzhko

I-13

29.10.2025 09:00–09:35

Magnetocaloric potential of the rare-earth hexaaluminates $CeMgAl_{11}O_{19}$ and $EuAl_{12}O_{19}$

Gael Bastien[1], Adam Elias[1], Tim Treu[2], Philipp Gegenwart[2], Ross Colman[1,*]

[1]Charles University, Faculty of Mathematics and Physics, Department of Condensed Matter Physics, Prague
[2]Universität Augsburg [Augsburg]

Abstract

The rare-earth hexaaluminates provide a versatile platform for exploring magnetocaloric refrigeration based on geometric frustration and strong anisotropy. We report recent advances in $CeMgAl_{11}O_{19}$ (CMAO) and $EuAl_{12}O_{19}$ (EAO). Indirect calculation of CMAO's cooling potential from magnetisation and heat capacity data, as well as direct adiabatic demagnetization measurements on CMAO confirm its performance as a sub-Kelvin refrigerant, with cooling from 2 K to below 100 mK during demagnetisation from 14 T [1]. In contrast, EAO is a strongly anisotropic ferromagnet [2]. The anisotropy results in a phase diagram that shows the possibility of rotational magnetocaloric cooling under low fields (<1 T). We present the first proof-of-concept direct measurements of the rMCE in EAO, where crystal rotation in a fixed magnetic field induces an adiabatic temperature change of $\sim$0.23 K at 2 K. These findings establish two complementary routes to solid-state cooling in similarly structured systems with very different underlying magnetism.

References
[1] G. Bastien et al., http://arxiv.org/abs/2506.16207 (2025).
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*Speaker: R. Colman

I-14

Quantum Monte Carlo studies of frustrated two-dimensional Heisenberg antiferromagnets

Nils Çaçi*
Collège de France, Sorbonne University, Paris, France

29.10.2025 10:25–11:00

Abstract

The study of frustrated quantum magnets forms an integral part of contemporary condensed matter research. In many cases, magnetic frustration leads to the manifestation of non-classical quantum phases. The stochastic series expansion quantum Monte Carlo method is a well established unbiased approach for the large scale study of quantum magnets. In its usual formulation, introducing geometric frustration however leads to the infamous sign problem, i.e., an exponential drop in the statistical accuracy of the method. We show here how for certain models this can be overcome by changing to a different basis consisting of few-site clusters and report results for several geometrically frustrated Heisenberg antiferromagnets.

*N. Çaçi

COOLMAG 2025

I-15

29.10.2025 11:00–11:20

Modeling and Optimization of ADR Systems for Next-Generation Millikelvin Cooling

*Peter Schüßler
kiutra GmbH

Abstract

Quantum technologies, in particular superconducting qubits, drive an urgent need for scalable and robust cooling solutions in the millikelvin regime. In the SPROUT project, we demonstrated continuous ADR operation below 30 mK in a compact refrigerator with the footprint of a standard 19" rack. Building on this success, the LEMON project develops a larger-scale ADR platform targeting 20 μW at 20 mK—an order of magnitude increase over the $\sim$3 μW at 50 mK achieved in SPROUT. Achieving this performance requires a fundamental redesign of key ADR components. To support this, we have developed and experimentally validated a modeling software package that captures the behavior of critical elements, including the cooling medium as well as mechanical and superconducting heat switches. This tool enables full ADR cycle simulations for different use cases and provides a powerful framework to derive targeted requirements for next-generation components.

*Speaker: *P. Schuessler*

Oral presentations

(15 min. talk + 5 min. discussion)

O-01

27.10.2025 10:10–10:30

Strong correlations within mean-field universality: Tensor Network studies

Andrej Gendiar[1,*], Matej Moško[1]

[1,*] Institute of Physics, Slovak Academy of Sciences, Bratislava

Abstract

Infinite-dimensional spin systems are known to belong to the mean-field universality class. We investigate the simple Ising model on the infinite-dimensional lattice that is locally three-dimensional. This is possible if the Gaussian curvature is negative, resulting in a hyperbolic 3D space embedded in infinite-dimensional space. We have developed a unique tensor network algorithm that enables us to study 3D spin systems on the cubic lattice, including those on the hyperbolic one. We briefly describe the Tensor Network ideas and focus on the phase-transition analysis in the thermodynamic limit. The phase transition emerges only in the bulk if strong boundary effects are suppressed. We analyze spontaneous magnetization, von Neumann entanglement entropy, and the correlation length to clarify how the long-standing problem of the mean-field universality class is revealed in hyperbolically curved 3D lattice geometries.

*Speaker: *A. Gendiar*

O-02

27.10.2025 12:10–12:30

Tetrahedral Core in a Sea of Competing Magnetic Phases in Graphene

Maxime Lucas[1,*], Andreas Honecker[1], Arnaud Ralko[2], Guy Trambly De Laissardière[1]

[1]Laboratoire de Physique Théorique et Modélisation, Centre National de la Recherche Scientifique, CY Cergy Paris Université
[2]Institut NEEL (Institut NEEL); Université Grenoble Alpes, CNRS : UPR2940 38042 Grenoble - France

Abstract

Recent studies of twisted bilayer graphene (or other 2D materials) have been stimulated by the discovery of correlations between electronic flat-band states due to a moiré pattern. It is shown experimentally and theoretically that the filling of the flat bands affects their magnetic properties significantly. On the other hand, the effect of doping on a simple graphene layer is still unclear. Indeed, its half-filled case is well known, but unlike other lattices its magnetic properties beyond half filling are mostly unexplored, except at 1/4 doping. Here, we present our analysis of graphene magnetism using a combination of the Hubbard model and Hartree-Fock mean-field theory. We work at density values around 1/4 doping corresponding to a Van Hove singularity.

*Speaker: M. Lucas

O-03

27.10.2025 15:40–16:00

Skyrmion crystal phase in a frustrated antiferromagnetic triangular lattice with DMI

Mariia Mohylna[1], Milan Žukovič[2,*]

[1] Department of Applied Physics, School of Engineering Sciences, KTH Royal Institute of Technology, AlbaNova University Center, SE-10691 Stockholm, Sweden

[2] Institute of Physics, Faculty of Science, P. J. Šafárik University in Košice, Park Angelinum 9, 041 54 Košice, Slovakia

Abstract

We study a frustrated antiferromagnetic (AFM) Heisenberg model on a triangular lattice with the Dzyaloshinskii–Moriya interaction (DMI) in the presence of an external magnetic field [1,2] by parallel tempering. The focus is laid on effects of a single-ion anisotropy [3] and non-magnetic impurities [4] on the overall phase diagram topology and the skyrmion lattice (SkX) phase stability. The phase diagram features up to four ordered phases, including the SkX phase that is stabilized within some temperature and field window for sufficiently large DMI and not too strong anisotropy. Our results suggest that while a strong single-ion anisotropy has overall destructive effects on the SkX phase, a weaker anisotropy can be beneficial. Namely, it can either increase the range of the field values at which SkX is stabilized (easy-plane type) or shift the entire field range to smaller values (easy-axis type). A weak easy-plane anisotropy also supports the skyrmion persistence in the absence of the external field. The SkX phase in the present frustrated AFM system turns out to be much more robust against the distortion induced by the impurities than the one in its unfrustrated FM counterpart [5].

Acknowledgements

This work was supported by the Slovak Research and Development Agency under the Contract no. APVV-24-0091 and the Scientific Grant Agency of the Ministry of Education of Slovak Republic (Grant No. 1/0695/23).

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[4] M. Mohylna, M. Žukovič, Magnetochemistry 9 101 (2023).
[5] R. Silva et al., Phys. Rev. B 89 054434 (2014).

*Speaker: M. Žukovič

O-04

27.10.2025 17:05–17:25

Slave Spin study of the Mott transition and Antiferromagnetism in the 2D Hubbard Model

Youssra Anene[1,*], Lorenzo Fratino[1]

Laboratoire de Physique Théorique et Modélisation, Centre National de la Recherche Scientifique, CY Cergy Paris Université

Abstract

We investigate the two dimensional Hubbard model using the slave spin mean field method across different lattice geometries. This approach provides an economical way to study both the paramagnetic and antiferromagnetic phases of strongly correlated electrons and is especially valued for its agility in treating multiorbital systems. In the paramagnetic regime, it captures the Mott metal-insulator transition and shows how lattice geometry affects the critical interaction strength. In the antiferromagnetic phase, it clarifies the role of electronic correlations and magnetic order. These results highlight the effectiveness of the slave spin method for exploring strongly correlated electron systems.

[*] *Speaker: Y. Anene*

O-05

28.10.2025 09:55–10:15

Topological Devil's staircase in a constrained kagome Ising antiferromagnet

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[2]Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut NEEL, 38000 Grenoble, France

Abstract

The first neighbour antiferromagnetic Ising model on the Kagome lattice is highly frustrated, resisting order up to zero temperature (Classical Spin Liquid) and hosting a macroscopically degenerate family of ground states. In experimental realizations of this frustrated Ising model, however, residual interactions may select a single ground state and prevent the observation of the Classical Spin Liquid. This is what happens in Kagome out-of-plane artificial spin systems, where long range antiferromagnetic interactions lift the ground-state degeneracy and order the system at low temperatures. On the Kagome lattice the lifting of degeneracy is gradual and, if interactions are truncated at the third nearest-neighbour ($J_1 - J_2 - J_3$ Kagome Ising antiferromagnet), three phases with distinct residual entropies can be stabilized depending on the relative strength of J_2 and J_3.

We report on a novel scenario for phase transition found in the constrained model implementing the $J_1, J_3 \to \infty$ limit of the $J_1 - J_2 - J_3$ Kagome Ising antiferromagnet, whose ground state is partially ordered. In this constrained model we show that the Kasteleyn transition, the condensation of linear defects in a fluctuation-free low-temperature phase, takes an exotic form due to the coexistence of two types of linear defects. The ratio in density of the two kinds of defects is quantized to integer values and the density of either type of defect jumps when this number changes by one, in contrast to the standard case where the density of defects continuously increases as $(T - T_c)^{1/2}$. This leads to a devil's staircase of topological origin, between phases with different values of an integer topological number: the density ratio. By contrast to the devil's staircase of the ANNNI and related models, the wave-vector is not fixed to commensurate values inside each phase.

[*]*Speaker: A. Rufino*

O-06

28.10.2025 11:20–11:40

Cluster spin glass in Co-Al layered double hydroxides

E. Čižmár[1,*], V. Tkáč[1], E.L. Fertman[2], A.V. Fedorchenko[2], Yu.G. Pashkevich[3,4], M. Holub[5], R. Tarasenko[1], A. Feher[1], C.S. Neves[6], D.E.L. Vieira[6], A.N. Salak[6]

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[6]Department of Materials and Ceramics Engineering, CICECO – Aveiro Institute of Materials, University of Aveiro, 3810-193 Aveiro, Portugal

Abstract

Frequency-dependent magnetic behaviour of Co-Al layered double hydroxides (LDH) with the Co/Al ratio (n) of 2 and 3, and the basal spacing values in the range of 0.76-1.66 nm was studied in detail between 2 and 300 K. It was found from analysis of the temperature-dependent ac magnetic susceptibility measured at different frequencies that the studied LDH exhibit a magnetic cluster spin glass (spin glass-like) behaviour regardless of their basal spacing value and the Co/Al ratio as evidenced by $E_A/k_\mathrm{B}T_0 > 1$ relation as obtained from the analysis using Vogel-Fulcher law [1]. The obtained values of Mydosh parameters in the range of 0.017-0.052 suggest that some of these materials are not far from the canonical spin glasses, implying a rather small size of the magnetic clusters. The specific heat of non-magnetic Mg-Al LDH at low temperatures temperatures revealed their 2D solid and structural glass character [2]. The reduced C(T)/T^3 of Mg-Al LDH intercalated with nitrate was found to demonstrate a so-called boson peak, which is a manifestation of a glassy state. The observed low-temperature structural glassy state in LDH was associated with the disorder of the intercalated species and can affect the creation of cluster spin glass in magnetic LDH.

Acknowledgements

The work was supported by the projects APVV-22-0172 and APVV-23-0006, and EU H2020 project European Microkelvin Platform (EMP), grant agreement No. 824109.

References

[1] E.L. Fertman et al., Chem. Phys. Lett., 859, (2025), 141745.
[2] V. Tkáč et. al., Appl. Clay Sci., 266, (2025), 107695.

Speaker: E. Čižmár

O-07

29.10.2025 09:35–09:55

Improved effective field formulation for obtaining magnetocaloric properties of the Ising model

Ümit Akıncı*
Dokuz Eylül University, Izmir, Turkey

Abstract

Magnetocaloric effect (MCE) is one of the main sources of magnetic cooling. It is realized in several compression-expansion cycles like a thermodynamic cycle. For an adiabatic process, by balancing between the lattice contribution and magnetic contribution of entropy, changing the magnetic order by applying a magnetic field yields a temperature change of the material. Thus, in calculations, isothermal magnetic entropy change (IMEC) has a key role. A large magnitude of IMEC spread in a broader temperature span is needed for a good candidate for magnetic refrigerant material. The full width at half maximum value of the IMEC (FWHM) is used for the above-mentioned temperature span. This temperature range is the range in which the magnetic entropy change gains half of the peak value. Combining the IMEC and FWHM concepts yields another important quantity: the refrigerant capacity (RC). All these quantities can be calculated for several magnetic models within several methods. But since the entropy calculations are expensive calculations, it is necessary to develop more efficient methods for determining the magnetocaloric properties of the materials.

Although a special case of the Heisenberg model, the Ising model can be used to determine the magnetic properties of some materials, such as Gd. In this talk, we give the results of the improved effective field formulation [1] for the Ising model in terms of the MCE.

[1] Ü. Akıncı, "New cluster approximation for Ising systems"Journal of Magnetism and Magnetic Materials, Volume 499, 2020, 166324, https://doi.org/10.1016/j.jmmm.2019.166324.

*Speaker: *Ü. Akıncı*

Short oral communications

(5 min. talk + 5 min. discussion)

SOC-01

27.10.2025 17:25–17:35

Quantum Entanglement Generation in Heterometallic $Ni_4^{2+}Gd_4^{3+}$ Complexes

Hamid Arian Zad[1,*], Michal Jaščur[1], Azam Zoshki[1], Ralph Kenna[2], Nerses Ananikian[3]

[1] University of Pavol Jozef Šafárik
[2]Centre for Fluid and Complex Systems
[3]A. I. Alikhanyan National Science Laboratory

Abstract

We investigate various types of quantum entanglement in the octanuclear heterometallic 3d/4f complexes denoted as $Ni_4^{2+}Gd_4^{3+}$ under an external magnetic field, using the exact diagonalization approach. These molecular magnets, which can be effectively described by Heisenberg spin models, consist of two identical $Ni_4^{2+}Gd_4^{3+}$ cubane subunits bridged by acetate and hydroxide ligands. Our analysis reveals that their magnetization exhibits intermediate plateaus at low temperatures, indicating distinct ground states characteristic of Ni-containing compounds. Using negativity as a measure of quantum entanglement, we examine the influence of single-ion anisotropy and magnetic field on tetrapartite, bipartite, 1–3 tangle, and 2–2 tangle entanglements in two families of $Ni_4^{2+}Gd_4^{3+}$ complexes: (1) without anisotropy and (2) with anisotropy. Complex (1) exhibits strong bipartite entanglement between Ni ions, which persists up to T ≈ 3.0 K and B ≈ 4.0 T, but shows significantly weaker tetrapartite entanglement and vanishing bipartite entanglement between Gd···Gd and Ni···Gd pairs. In contrast, complex (2) displays nonzero and sizable values for all types of entanglement considered. These findings emphasize the crucial role of single-ion anisotropy in generating and shaping the entanglement landscape of heterometallic $Ni_4^{2+}Gd_4^{3+}$ complexes. Notably, we find that the 1–3 tangle entanglement between a Ni ion and the remaining sites in a cubane unit serves as a reliable indicator of ground-state phase transitions, exhibiting distinct changes across phase boundaries irrespective of the presence of single-ion anisotropy.

[*] *Speaker: H. Arian Zad*

SOC-02

27.10.2025 17:35–17:45

Magnetic properties of the $S = \frac{1}{2}$ quantum magnet Cu(tn)Cl_2

Ali Darwich[1,*], Róbert Tarasenko[1], Erik Čižmár[1], Martin Orendáč[1], Alžbeta Orendáčová[1]

[1] University of Pavol Jozef Šafárik

Abstract

Cu(tn)Cl_2 represents a quasi-two-dimensional (2D) quantum magnet which preserves 2D features far below the phase transition to the ordered state at 0.55 K. Previous studies (1) of powdered identified the compound as a candidate for the realization of the spin-1/2 HAF model on the spatially anisotropic triangular lattice with i.e. with pronounced square-lattice features. The effective intralayer coupling has been estimated . Present work is devoted to the single crystal studies of field and temperature dependence of magnetization in the field applied along the a axis. This orientation is characterized by appearance of additional magnetic phase in the magnetic phase diagram. Analysis of magnetic susceptibility and isothermal magnetization was performed within the model of a rectangular lattice - a rough approximation of the magnetic lattice based on the previous results of first-principle calculations of exchange couplings (2). The data showed significant deviations from the rectangular lattice model while zero-field specific heat was in excellent agreement with this model for the ratio where and represent nearest neighbor couplings in the rectangular lattice. No traces of hysteresis were indicated in the magnetization at 0.45 K which excludes the presence of weak ferromagnetism.

*Speaker: *A. Darwich*

SOC-03

27.10.2025 17:45–17:55

Molecular nanomagnet $Cu^{2+}Ni^{2+}Cu^{2+}$ as a resource for bipartite and tripartite quantum entanglement and coherence

Azadeh Ghannadan[1,*], Hamid Arian Zad[2], Saeed Haddadi[3], Jozef Strečka[2], Zhirayr Adamyan[4], Vadim Ohanyan[4]

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[2] Institute of Physics, Faculty of Science, P. J. Šafárik University in Košice, Park Angelinum 9, 041 54 Košice, Slovakia
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[4] Laboratory of Theoretical Physics, Yerevan State University, 1 Alex Manoogian Str., 0025 Yerevan, Armenia

Abstract

We investigate key quantum characteristics of the mixed spin-(1/2,1,1/2) Heisenberg trimer under the influence of an external magnetic field. Specifically, we analyze the distributions of bipartite and tripartite entanglement quantified through the respective negativities and the l1-norm of coherence with the help of rigorous analytical and numerical methods. Our findings suggest that the heterotrinuclear molecular nanomagnet $[\{Cu^{2+}L\}_2Ni^{2+}(H_2O)_2](ClO_4)_2 \cdot 3H_2O$, which represents an experimental realization of the mixed spin-(1/2,1,1/2) Heisenberg trimer, exhibits a significant bipartite entanglement between Cu^{2+} and Ni^{2+} magnetic ions along with robust tripartite entanglement among all three constituent $Cu^{2+}Ni^{2+}Cu^{2+}$ magnetic ions. The significant bipartite and tripartite entanglement persists even at relatively high temperatures up to 37K and magnetic fields up to 46 T, whereby the coherence is maintained even at elevated temperatures. It is evidenced that the aforementioned molecular complex with the magnetic core $Cu^{2+}Ni^{2+}Cu^{2+}$ provides an intriguing quantum resource, which exhibits a star-shaped state within the singlet eigenstate at low magnetic fields and W-like state within the triplet eigenstate at moderate magnetic fields.

*Speaker: A. Ghannadan

SOC-04

27.10.2025 17:55–18:05

Experimental Study of Large Rotational Magnetocaloric Effect in the Anisotropic Rare-Earth Molybdate $KDy(MoO_4)_2$

Illia Kozin[1,*], Róbert Tarasenko[1], Vladimír Tkáč[1], Alžbeta Orendáčová[1], Martin Orendáč[1]

[1] Institute of Physics, Faculty of Science, P. J. Šafárik University in Košice, Park Angelinum 9, 041 54 Košice, Slovakia

Abstract

The presented double molybdate $KDy(MoO_4)_2$ is a rare-earth-based compound in which the Jahn–Teller effect produces a pronounced anisotropy in the Dy^{3+} electronic states. This anisotropy enables external magnetic fields to significantly modify macroscopic properties of the studied system. $KDy(MoO_4)_2$ exhibits two structural phases: a high-temperature disordered phase and a low-temperature ordered phase characterized by ferriquadrupolar alignment of Dy^{3+} quadrupole magnetic moments, with a transition temperature around 14 K [1].

In this work, we present an experimental investigation of the rotational magnetocaloric effect (RMCE) in $KDy(MoO_4)_2$. A plate-shaped crystal with well-defined crystallographic axes was measured in a commercial Magnetic Property Measurement System (MPMS) in the temperature range 1.8 – 50 K and magnetic fields up to 5 T. Field-dependent magnetization measurements were done for different field orientations with respect to the crystallographic axes, enabling a numerical evaluation of the magnetic entropy change upon rotation of the sample in a constant magnetic field.

A large rotational magnetic entropy change ≈ 9.3 $Jkg^{-1}K^{-1}$ and ≈ 9 $Jkg^{-1}K^{-1}$ is achieved in 5 T during rotation of crystal from b axis to c axis and a axis to c axis, respectively.

Acknowledgements

The financial support by the projects APVV-22-0172, APVV-23-0006 and VEGA 1/0132/22 is highly appreciated.

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*Speaker: I. Kozin

SOC-05

27.10.2025 18:05–18:15

Which dimension governs scaling on fractals? Ising criticality on a 3D fractal with Hausdorff dimension 2.5 and "boundary"dimension 2

Jozef Genzor[1], Roman Krčmár[2,*], Hiroshi Ueda[3,4], Denis Kochan[5], Andrej Gendiar[6], Tomotoshi Nishino[7]

[1]Department of Physics and Center for Theoretical Physics, National Taiwan University, Taipei 10607
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[4]JST Presto
[5]University of Regensburg (UR)
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[7]Kobe University

Abstract

Our long-term program asks a simple question with a slippery answer: on fractal lattices, which "dimension" sets the rules of critical scaling—Hausdorff, spectral, or boundary/connectivity? We present a compact test case: the classical Ising model on a deterministic three-dimensional fractal that, at each iteration, retains 32 of the 64 subcubes. This construction yields a Hausdorff dimension of 2.5, while the number of boundary bonds grows as if the boundary had dimension 2. Using higher-order tensor renormalization (HOTRG), we identify a sharp phase transition at a critical temperature near 2.65231, with magnetization exponent beta about 0.059 and critical-isotherm exponent delta about 35. Crucially, the specific heat shows a weak but clear divergence—unlike our earlier two-dimensional fractal case (Hausdorff roughly 1.792), where no divergence appeared. Taken together, these results suggest that boundary/connectivity controls the existence of thermodynamic singularities, while the effective dimension entering hyperscaling should be treated as an empirical observable that need not coincide with the Hausdorff or spectral dimension.

*Speaker: R. Krčmár

SOC-06

27.10.2025 18:15–18:25

Study of direct magnetocaloric effect in the $S = \frac{1}{2}$ spatially anisotropic triangular quantum magnet $Cu(tn)Cl_2$

Ali Darwich[1], Róbert Tarasenko[1], Erik Čižmár[1], Martin Orendáč[1], Alžbeta Orendáčová[1,*]

[1] Institute of Physics, Faculty of Science, P.J. Šafárik University in Košice

Abstract

$Cu(tn)Cl_2$ (tn = 1,3-diaminopropane = $C_3H_{10}N_2$) represents a quasi-two-dimensional (2D) quantum magnet which preserves 2D features far below the phase transition to the ordered state at 0.55 K. The presence of large quantum fluctuations typical for low-dimensional magnetism was previously indicated by T2 dependence of specific heat, the lack of oscillations in muon time spectra down to 40 mK and nonmonotonic character of magnetic phase diagram [1]. These 2D features can be ascribed to the incommensurate modulated crystal structure recently revealed in $Cu(tn)Cl_2$. The modulation leads to the formation of extremely thin regions with a thickness running from one to four unit cells which differ in the orientation of tn ligands. Since previous ab initio studies revealed high sensitivity of exchange interactions on the selected tn positions, large variability of exchange couplings in the thin layers can be expected. However, no spin freezing was indicated. The inclusion of two strongest nearest-neighbor exchange couplings from those provided by the ab initio studies performed for one tn position leads to formation of effective rectangular lattice. While excellent agreement between specific heat data and the effective model was achieved, significant deviations appear in the description of magnetic susceptibility and magnetic phase diagram, where additional phase in the vicinity of a critical region appears [1]. Since the phase appears in the fields perpendicular to the direction of the modulation vector, its dependence on the field orientation may be caused by the spatial and spin anisotropies. Present work is devoted to the direct magnetocaloric effect investigated in the low-field region of magnetic phase diagram.

Acknowledgements

The financial support of projects VEGA 1/0132/22, APVV-18-0197 and APVV-22-0172 is acknowledged.

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DOI: 10.1103/PhysRevB.108.214432

*Speaker: A. Orendáčová

SOC-07

27.10.2025 18:25–18:35

Quantum entanglement in the bilinear biquadratic spin-1 chain

Malo Rouxel*

Laboratoire de Physique Théorique et Modélisation, CY Cergy Paris Université

Abstract

The spin-1 bilinear-biquadratic chain represents the most general model for an isotropic exchange interaction within such a chain. The Hamiltonian of this chain can be expressed as a function of θ, the chain exhibiting several phases depending on the value of its value. To characterize the different phases while avoiding the entire spectral decomposition computation, entanglement within the ground state is investigated. This ground state is obtained by diagonalizing the Hamiltonian using an algorithm similar to the Lanczos algorithm. As the ground state can be degenerate, symmetries and conservations are also studied to achieve a non-degenerate ground state. It is demonstrated that proper multipartite entanglement measures enable the differentiation of various behaviors and the identification of the corresponding phases.

*Speaker: M. Rouxel

SOC-08

28.10.2025 17:35–17:45

A Combined Theoretical and Experimental Determination of Quantum Entanglement in a Spin-1/2 Heisenberg Tetrahedron via Inelastic Neutron Scattering

Elham Shahhosseini Shahrabadi[1,*], Hana Vargová[2], Jozef Strečka[1]

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Abstract

This study accurately investigates the dynamical autocorrelations and correlation functions of the spin-1/2 Heisenberg tetrahedron using exact diagonalization method at zero as well as nonzero temperatures. Our research aims to establish a direct link between experimentally accessible quantities and fundamental quantum entanglement measures. We compute the static and dynamic structure factors, which are directly measurable through inelastic neutron scattering experiments. By combining this experimentally accessible data with basic magnetometry measurements, our work shows how bipartite entanglement measures such as concurrence and negativity can be determined. A significant finding is the observation of anomalous, temperature-induced variations in both the structure factors and the entanglement measures. These anomalies occur near two specific magnetic fields, at which level crossings between singlet-triplet and triplet-quintet states occur. The theoretical validity of our results is confirmed by their adherence to sum rules for the dynamic structure factor, which ensures the conservation of spectral weight.

*Speaker: E. Shahhosseini Shahrabadi

SOC-09

28.10.2025 17:45–17:55

Investigation of Thermal Conductivity and Heat Capacity of $Dy_xY_{1-x}(PO_3)_3$ glasses

Vladyslav Stadnyk[1,*], Vladimír Tkáč[1], Martin Tokarčík[1], Pavlo Baloh[2], Róbert Tarasenko[1], Erik Čižmár[1], Alžbeta Orendáčová[1], Jana Holubová[3], Eva Černošková[3], Zdeněk Černošek[3], Alexander Feher[1]

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[3] Department of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Studentská 573, 532 10 Pardubice, Czech Republic

Abstract

This work focuses on the thermal properties of phosphate glasses doped with Dy^{3+} rare-earth ions, $Dy_xY_{1-x}(PO_3)_3$, with varying Dy^{3+} concentrations at low temperatures. The research investigates heat transport in samples containing magnetic Dy3+ ions and non-magnetic Y^{3+} ions, examining the impact of crystal electric field effects on Dy^{3+} within a disordered glassy structure.

$Dy_xY_{1-x}(PO_3)_3$ (x = 0, 0.0001, 0.001, 0.01, 0.1, 1) were examined through heat capacity Cp and thermal conductivity κ(T) measurements. Heat capacity measurements were performed using the relaxation method in the temperature range of T = 0.4 – 20 K under magnetic fields of up to 9T, while thermal conductivity was measured in the temperature range of T = 1.8 – 300 K using the two-probe method. The results confirm the presence of a boson peak in Cp/T3 in all studied samples and onset of a Schottky anomaly in Dy-doped glasses.

Thermal conductivity measurements showed typical glass-like behaviour: a plateau in κ(T) between $T \approx 5$ K and 20 K. Below 5 K is observed onset on κ(T) $\sim$ T2 and a slight increase of κ(T) above T = 15 K. Magnetic Dy^{3+} ions influence phonon transport and the absolute values of thermal conductivity nontrivial way. The results demonstrate how Dy^{3+} ions influence phonon transport through magnetic and phonon scattering.

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*Speaker: V. Stadnyk

SOC-10

28.10.2025 17:55–18:05

Magnetocaloric effect in a deformable quantum spin–1/2 XX chain in a transverse magnetic field

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Abstract

Incorporating magnetoelastic coupling into one-dimensional spin models not only makes them more realistic but also gives rise to novel physical phenomena. In this work, we study the deformable quantum spin-1/2 XX chain subjected to a transverse magnetic field, which remains exactly solvable through a combination of Jordan-Wigner and Fourier transformations. Lattice deformations are introduced by considering a magnetoelastic coupling that depends linearly on the lattice distortion [1]. Our main result is the variational Gibbs free energy, obtained and subsequently minimized with respect to a small distortion parameter. Based on this framework, we compute the magnetization and magnetic susceptibility as key indicators of the magnetic properties. Furthermore, we analyze the elastic response of the system by examining the equilibrium distortion parameter and the inverse compressibility in detail. While the rigid spin-1/2 XX chain exhibits a quantum phase transition driven solely by the transverse magnetic field, the deformable counterpart displays a qualitatively different behavior. Specifically, we uncover a line of discontinuous phase transitions extending from zero up to finite temperatures, which terminates at a critical point corresponding to a continuous thermal phase transition. At sufficiently low temperatures, these thermal first-order transitions are accompanied by magnetic hysteresis, which gradually diminishes as the temperature increases. Furthermore, we investigated the magnetocaloric properties of this chain, which are most pronounced near the transition line, focusing on the adiabatic temperature change and the isothermal entropy change.

Acknowledgements

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*Speaker: *D. Sivý*

SOC-11

28.10.2025 18:05–18:15

Crystal-field anisotropy as the origin of a large magnetocaloric effect in $Ni(en)_2Ni(CN)_4$

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Abstract

Experimental investigations of the thermodynamic behavior of $Ni(en)_2Ni(CN)_4$ (en = $C_2H_8N_2$), commonly referred to as NENC, indicate that the compound can be modeled as an $S = 1$ antiferromagnetic Heisenberg chain with strong planar anisotropy ($D/k_B = 6.3$K) and weak in-plane anisotropy (E/k_B = 0.9 K), yielding $D/|J|$ = 7.5. Electron spin resonance measurements confirmed the presence of single-ion bound states in NENC. The compound crystallizes in the monoclinic space group $P2_1/n$ with lattice parameters $a = 7.104, b = 10.671, andc = 9.940$. Its structure consists of infinite, charge-neutral chains of [-NC–Ni(1)–$(CN)_2$–CN–Ni(2)$(en)_2$]∞ aligned along the c-axis. Ni(1) is square-planar coordinated by four cyano groups, making it diamagnetic, whereas Ni(2) occupies the center of a distorted octahedron, coordinated by four nitrogen atoms from two en ligands in the basal plane and two nitrogen atoms from cyano groups in apical positions. Magnetocaloric measurements were performed on a 0.42 mg single crystal of NENC in magnetic fields up to 5 T applied along the b-axis over the temperature range 2–10 K. Isothermal magnetization curves were obtained using a Quantum Design SQUID magnetometer. The magnetocaloric effect was theoretically estimated using a simple spin-1 paramagnetic model with crystal-field splitting described by D and E parameters. A large conventional magnetocaloric effect was observed near 3.5 K ($-\Delta S_{\max}$ = 12 $\mathrm{Jkg^{-1}K^{-1}}$ at 5 T). The temperature dependence of the isothermal entropy change under various magnetic fields agrees well with predictions based on crystal-field parameters.

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*Speaker: R. Tarasenko

SOC-12

28.10.2025 18:15–18:25

Magnetic relaxation of the $Dy_xY_{1-x}(PO_3)_3$ glasses

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Abstract

Magnetic properties of rare-earth ions are typically investigated in periodic crystal lattices, where the crystal electric field (CEF) is uniform for all magnetic ions. In contrast, we studied $Dy_xY_{1-x}(PO_3)_3$ glasses with Dy^{3+} concentrations x = 0, 0.0001, 0.001, 0.01, 0.1, and 1. For the non-magnetic sample (x = 0), the specific heat exhibits a boson peak at TBP $\approx$ 12 K, characteristic of amorphous materials [1]. Magnetic samples ($x \neq 0$) show an additional contribution, manifested as a Schottky anomaly in the x = 1 sample, whose magnitude decreases with Dy3+ dilution. Applying an external magnetic field shifts this anomaly to higher temperatures and reduces its amplitude.

Magnetization measurements at 1.8 K revealed saturation values below the expected μ_{eff} = 10.65 μB, attributed to the strong anisotropy of Dy^{3+}. The magnetic susceptibility between 1.8 and 300 K showed no difference between the zero-field-cooled and field-cooled regimes, indicating the absence of magnetic ordering. Curie–Weiss analysis indicated weak antiferromagnetic interactions, which diminished with a lower Dy^{3+} content, while the effective moment at 300 K remained close to μ_{eff} = 10.65 μB.

AC susceptibility revealed slow magnetic relaxation in zero field, governed by a single relaxation process. The characteristic frequency decreases with Dy^{3+} dilution: above 10 kHz for x = 1, 3 kHz for x = 0.1, 730 Hz for x = 0.01, 20 Hz for x = 0.001, and below 0.1 Hz for x = 0.0001, likely due to weakened Dy^{3+}–Dy^{3+} interactions.

Acknowledgements

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*Speaker: V. Tkáč

SOC-13

28.10.2025 18:25–18:35

Field-orientation-dependent magnetocaloric effect in an anisotropic mixed spin-(1/2,1) Heisenberg dimer

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Abstract

We present an exact analysis of the anisotropic mixed spin-(1/2,1) Heisenberg dimer in an external magnetic field applied along two principal orientations: parallel and perpendicular to the dimer axis. The model includes exchange anisotropy and uniaxial single-ion anisotropy, with identical Landé g-factors assumed for all spins. Ground-state phase diagrams reveal a single type of zero-temperature phase transition, accompanied by finite residual entropy, in both field orientations. The magnetocaloric behaviour is characterised by exact calculations of the adiabatic temperature change and isothermal entropy change under field rotation. Our results demonstrate that the conventional magnetocaloric effect occurs exclusively for the perpendicular field orientation, whereas a small inverse magnetocaloric effect can arise in the parallel orientation in the easy-plane case of single-ion anisotropy. Moreover, the magnetocaloric response is strongly sensitive to the field orientation, particularly for small magnetic-field variations, depending on the strengths of both anisotropies.

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Speaker: H. Vargová

SOC-14

28.10.2025 18:35–18:45

Magnetic Signatures of the Localized Magnon States in a Spin-1/2 Four-Leg Tube

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Abstract

The magnetic phase diagram of the spin-1/2 Heisenberg antiferromagnet on a four-leg tube [1] is investigated in the presence of an external magnetic field. We employ a complementary approach that integrates the analytical framework of localized magnons [2] with high-accuracy numerical methods, including exact diagonalization, to explore the magnetic and thermodynamic behavior of the model in the strongly frustrated regime $J_2/J_1 > 2$. To uncover the magnetic properties of the model in the regime $J_2/J_1 < 2$, we implement the density-matrix renormalization group (DMRG). Our study reveals a rich sequence of field-induced quantum phases, including quantum spin liquid and bound-magnon crystal phases [3]. These phases manifest in the magnetization process through unconventional features such as quantized plateaus and abrupt jumps, which are quantitatively explained within the localized magnon theory.

Acknowledgements

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*Speaker: A. Zoshki

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