qumics

February 19th - 21st, 2025
Neuville-sur-Oise, France

Programme & Abstracts

Organizing Committee: Katarína Karľová
Andreas Honecker
Jozef Strečka

Conference Date and Location

The workshop will be held on February 19th - 21st, 2025 in CY Advanced Studies, 1 rue Descartes, Neuville-sur-Osie 95 000, France.

Conference Language

The working language of the conference is English.

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
8. Flat-band physics in two dimensions
8. Exactly solved lattice-statistical models

List of Invited Speakers

Natalia Chepiga	Delft University of Technology, Netherlands
Oleg Derzhko	Institute for Condensed Matter Physics, L'viv, Ukraine
Marco Evangelisti	CSIC-Universidad de Zaragoza, Spain
Marcelo Jaime	PTB Braunschweig, Germany
Nicola Kelly	University of Cambridge, Great Britain
Frédéric Mila	EPFL, Lausanne, Switzerland
Sukhi Singh	Multiverse Computing, Spadina Ave., Toronto, Canada
Karlo Penc	Wigner Research Centre for Physics, Budapest, Hungary
Jürgen Schnack	Universität Bielefeld, Germany
Stefan Wessel	RWTH Aachen University, Germany
Mike Zhitomirsky	PHELIQS, CEA Grenoble - Université Grenoble Alpes, France

Programme - Wednesday February 19th, 2025

9.40-10.00 Registration

10.00-10.10 Opening

10.10-10.55 Invited lecture - I1:

O. Derzhko

Flat-band physics on highly-frustrated kagome bilayer

10.55-11.20 Oral presentation - O1:

R. Tarasenko, I. Kozin, A. Orendacova, E. Cizmar, V. Tkáč, and M. Orendáč

Fingerprints of field-induced Berezinskii–Kosterlitz–Thouless transition in Cu(C6H2(COO)4)(C2H5NH3)2 – A quasi-two-dimensional S = 1/2 antiferromagnet on rectangular lattice

11.20-11.45 Oral presentation - O2:

L. Fratino

Voltage-controlled magnetism driven by electrical triggering of a metal-insulator transition

11.45-12.05 Coffee break

12.05-12.50 Invited lecture - I2:

M. Evangelisti

Molecule-based magnetocalorics

12.50-13.15 Oral presentation - O3:

M. Lucas

Analysis of magnetism in monolayer graphene near 1/4 doping

13.15-14.30 Lunch

14.30-15.15 **Invited lecture - I3:**

F. Mila

Quantized Kasteleyn transition in a frustrated Ising model on the kagome lattice

15.15-15.40 **Oral presentation - O4:**

F. Berardi, E. Koskelo, L. Nagle-Cocco, C. Liu, H. Fischer, and S. Dutton

Magnetic properties of frustrated fcc oxides with general spin-(1/2,S) formula A2GdMO6 (A=Ba, Sr, Ca; M=Sb, Nb) for cryogenic refrigeration

15.40-16.05 **Coffee break**

16.05-16.30 **Oral presentation - O5:**

M. Ulaga, Jure Kokalj, Takami Tohyama, Peter Prelovšek

Easy-axis Heisenberg model on the triangular lattice: from supersolid to gapped solid

16.30-17.15 **Invited lecture - I5:**

J. Schnack

Toroidal magnetic molecules for quantum information

Programme - Thursday February 20th, 2025

10.00-10.45 **Invited lecture - I6:**

S. Singh

Flexible Tensor Networks for Simulating Irregular Many-Body Systems

10.45-11.10 **Oral presentation - O6:**

E. Kermarrec, F. Bert, P. Mendels, P. Puphal, D. Chatterjee, S. Suellow, J. Willwater, and Q. Barthélemy
Quantum magnetism of the anisotropic kagome antiferromagnet Y-kapellasite

11.10-11.35 **Oral presentation - O7:**

A. Gendiar, R. Krčmár, M. Moško

Entanglement in Tensor Networks

11.35-12.00 **Coffee break**

12.00-12.45 **Invited lecture - I7:**

N. Chepiga

Dimerization transitions in spin-S chains

12.45-13.10 **Oral presentation - O8:**

A. Jesche, A. Klinger, M. Klinger, T. Treu, P. Gegenwart

Adiabatic demagnetization refrigeration in the vicinity of magnetic ordering

13.10-14.10 **Lunch**

14.10-14.30 **Oral presentation - C:**

V. Marvaud

From High-Spin Complexes to Magnetic Dendrimers

14.30-15.15 Invited lecture - I8:

M. Jaime

Magnetocalorics in strongly correlated electron systems α-$RuCl_3$ and UTe_2

15.15-15.40 Coffee break

15.40-16.05 Oral presentation - O9:

S. Säubert

Large-Scale Magnetic Cooling for Quantum Computing

16.05-16.30 Oral presentation - O10:

D. Sivý, J. Strečka

Thermal or quantum phase transition in a deformable spin-1/2 Ising chain in a longitudinal or transverse magnetic field

16.30-18.00 Poster session

19.00-21.00 Conference dinner

Programme - Friday February 21st, 2025

10.00-10.45 **Invited talk - I9:**

A. Reingruber, N. Caci, **S. Wessel**, J. Richter

Thermodynamics of the spin-1/2 Heisenberg antiferromagnet on the star lattice

10.45-11.10 **Oral presentation - O11:**

A. Ghannadan, J. Strečka, K. Karľová

Magnetic-field-driven rise and fall of a bipartite entanglement in a spin-liquid phase of a spin-1/2 Heisenberg branched chain

11.10-11.40 **Coffee break**

11.40-12.25 **Oral presentation - I10:**

K. Penc

Negative thermal expansion in the plateau state of a magnetically-frustrated spinel

12.25-13.25 **Lunch**

13.25-14.10 **Invited talk - I11:**

N. Kelly

Magnetism on the triangular lattice in the lanthanide borates Ba3Ln(BO3)3 and LnBO3

14.10-14.30 **Oral presentation - O12:**

J. Strečka, F. Benabdallah, and M. Daoud

Enhancing fidelity in teleportation of a two-qubit state via a quantum communication channel formed by spin-1/2 Ising-Heisenberg trimer chains due to a magnetic field

14.30-14.35 **Closing**

Invited lectures

(40 min. talk + 5 min. discussion)

I1

Dimerization transitions in spin-S chains

N. Chepiga

Delft University of Technology, Netherlands

Abstract

In my talk I will discuss the nature of the quantum phase transitions into spontaneously dimerized phases of spin-S chains. Starting with the two textbook examples of the Kosterlitz-Thouless transition in spin-1/2 J_1-J_2 chain and the Wess-Zumino-Witten SU(2) level $k = 2$ transition at the Takhtajan-Babujian integrable point in the bilinear-biquadratic spin-1 chain I will discuss the nature of the transitions for $S > 1$. I will show that higher levels WZW critical theories can be realized in non-integrable spin chains including $k = 5$ for $S = 5/2$ and $k = 6$ for $S = 3$. This allows to make a generic predictions for continuous dimerization transitions for any value of S. I will also show that for half-integer spin chains with $S > 1/2$ the transition into the dimerized phase can take place via two intermediate phases: the partially dimerized gapped phase and the exotic floating phase characterized by a quasi-long-range incommensurability. Finally, I will discuss our recent progress on non-magnetic dimerization transitions.

Speaker: N. Chepiga

I2

Flat-band physics on highly-frustrated kagome bilayer

Oleg Derzhko

Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine (ICMP) – Svientsitskii Street 1, 79011 L'viv, Ukraine

Abstract

Quantum Heisenberg antiferromagnet on frustrated bilayer lattices provides a fascinating playground to examine flat-band physics [1,2,3]. The relevant regime appears when the nearest-neighbor intralayer coupling J_1 equals to the (frustrated) next-nearest-neighbor interlayer coupling $J_\times$, $J_1 = J_\times = J$, and the nearest-neighbor interlayer coupling J_2 exceeds a critical value $J_{2c}(J)$: Under such conditions, the lowest-energy magnon band is completely dispersionless (flat).

The present talk concerns a frustrated kagome-lattice bilayer, the low-temperature properties of which are essentially different in comparison to the ones of the square- or triangular-lattice bilayers. More precisely, the ground states in the subspaces with $S^z = N/2, \ldots, N/3$, $N = 2\mathcal{N}$ is the number of lattice sites, are independent singlets located on the J_2 bonds which respect a hard-core rhombi rule. As a result, these ground states can be mapped on hard-core rhombi on a kagome lattice or, equivalently, on hard dimers on a hexagonal lattice. The latter model is among well-known counting problems of combinatorics [4]. Moreover, for a hexagonal open boundary conditions, the entropy of close-packed dimers depends on the shape even if $\mathcal{N} \to \infty$ [5]. This result has important consequences for the frustrated quantum spin system under consideration at low temperatures when an external magnetic field is around the saturation: No finite-temperature order-disorder phase transition (related to ordering of the independent localized singlets on the J_2 bonds as for other bilayers [1,2]), dependence of the bulk properties on the system shape, or enhanced magnetocaloric effect [6].

This work was supported by the EURIZON project (Project No. 3025 "Frustrated quantum spin models to explain the properties of magnets over wide temperature range"), which is funded by the European Union under Grant No. 871072.

[1] J. Richter *et al.*, Phys. Rev. B **97**, 024405 (2018).
[2] J. Strečka *et al.*, Phys. Rev. B **98**, 174426 (2018).
[3] Y. Fan *et al.*, npj Quantum Materials **9**, 25 (2024).
[4] F. Y. Wu, Int. J. Mod. Phys. B **20**, 5357 (2006).
[5] V. Elser, J. Phys. A **17**, 1509 (1984).
[6] D. Yaremchuk *et al.*, in preparation.

Speaker: O. Derzhko

I3

Molecule-based magnetocalorics

Marco Evangelisti*[1]

[1]INMA, CSIC Universidad de Zaragoza – Spain

Abstract

Molecule-based magnetocalorics represent a fascinating area of research within the broader field of caloric materials. Unlike traditional magnetocaloric materials, molecule-based magnetocaloric materials use organic ligands to connect metal ions, resulting in the formation of molecular clusters or extended networks. This inherent versatility allows molecule-based magnetocaloric materials to adopt a variety of structures, which can enhance their magnetocaloric properties, particularly at low temperatures. In this presentation, I will highlight selected examples of molecule-based magnetocalorics, showcasing some of the recent findings from our research group.

*Speaker

sciencesconf.org:aqumics:602120

I4

Magnetocalorics in strongly correlated electron systems α-RuCl$_3$ and UTe$_2$

M. Jaime

I PTB Braunschweig, Germany

Abstract

I will discuss current topics in the experimental study of quantum phenomena induced by applying external magnetic fields at cryogenic temperatures. Here, complementary experimental techniques for electrical, lattice, and magnetocaloric properties in the microsecond timescale are used to investigate exotic states of matter in systems where quantum spin liquid (QSL) and field-induced superconductivity phases have been proposed.

First, I will discuss the implications that new magnetocaloric, thermal expansion, and magnetostriction data in α-RuCl$_3$ single crystals have on the material's temperature-field phase diagram when the low-temperature antiferromagnetic order is suppressed at H_c= 5-6.5 Tesla. Our magnetocaloric effect data provides, below 1 K, evidence for dissipative phenomena at H_c, a smoking gun for a first-order phase transition. Additionally, our results show little entropy involvement for a putative phase transition from a QSL to a polarized paramagnetic state proposed above H_c.[1]

UTe$_2$ (uranium ditelluride) is currently studied in the context of unconventional, potentially topological, superconductivity. It exhibits spin-triplet pairing, making it remarkably robust against external magnetic fields. Indeed, superconductivity in UTe$_2$ persists beyond 35 Tesla, far exceeding the simple Pauli limit for fields H || [010], (*b*-axis). In the second part of my talk, I will discuss an experimental study in magnetic fields up to 55 T applied between the [010] and [001] (c-axis) directions. Our MHz conductivity measurements reveal a field-induced highly conductive state. Concurrent magnetocaloric effect experiments provide the first definitive evidence of an excitations gap, and concomitant adiabaticity. Taken together, these findings are the hallmark of bulk field-induced superconductivity.[2]

[1] R. Schönemann, S. Imajo, F. Weickert, J. Yan, D.G. Mandrus, Y.0 Takano, E.L. Brosha, P.F.S. Rosa, S.E. Nagler, K. Kindo, and M. Jaime, Phys. Rev. B **102, 214432 (2020).**

[2] R. Schönemann, P.F.S. Rosa, S.M. Thomas, Y. Lai, D.N. Nguyen, J. Singleton, E.L. Brosha, R.D. McDonald, V. Zapf, B. Maiorov, and M. Jaime, PNAS Nexus 3, pgad428 (2024).

Speaker: M. Jaime

I5

Magnetism on the triangular lattice in the lanthanide borates Ba3Ln(BO3)3 and LnBO3

Nicola Kelly*[1,2]

[1]Cavendish Laboratory – United Kingdom
[2]Jesus College, University of Cambridge – United Kingdom

Abstract

The hexagonal (layered) polymorph of Ba3Ln(BO3)3 contains trivalent lanthanide (Ln) ions on a quasi-2D triangular lattice, resulting in strong geometric magnetic frustration. Several recent studies have been carried out on the spin-1/2 compound Ba3Yb(BO3)3 and the spin-3/2 compound Ba3Er(BO3)3, with unusual magnetic behaviour indicating quantum dipole-dipole interactions or two-sublattice exchange interactions respectively. Both compounds contain Kramers' ions with an odd number of electrons, which are therefore expected to have a symmetry-protected doublet ground state. We synthesised the non-Kramers isostructural analogue, Ba3Tb(BO3)3, and investigated its structure and magnetic properties down to a minimum temperature of 75 mK using specific heat, powder neutron diffraction (PND), inelastic neutron scattering (INS) and muon-spin relaxation spectroscopy (μSR). I will also discuss some recent work on another family of layered borates with a triangular lattice, LnBO3. These materials show potential for magnetocaloric cooling at liquid helium temperatures. However, they can adopt many different structures (depending on Ln size, temperature, pressure), some of which are still under active debate. We have used neutron total scattering to investigate disorder in the vaterite or "pi" polymorph of LnBO3. This disorder may be synthesis-dependent and is certainly expected to affect the magnetic behaviour.

*Speaker

I6

Quantized Kasteleyn transition in a frustrated Ising model on the kagome lattice

Frédéric Mila*[1]

[1]Ecole Polytechnique Fédérale de Lausanne (EPFL) – Swiss Federal Institute of Technology EPFL-FSTI IEL-LTS2, Station 11 Lausanne 1015 - Switzerland, Switzerland

Abstract

We show that the Kasteleyn transition, the condensation of linear defects in a fluctuation-free low-temperature phase, takes an exotic form in the partially ordered phase of the constrained Kagome Ising antiferromagnet with infinite first and third neighbor couplings, due to the coexistence of two types of linear defects. The number of defects of one type between consecutive pairs of the other type is quantized to integer values and defines a topological index. The density of either type of defect jumps when this topological changes by one, leading to an infinite sequence of thermal first-order transitions. This should be contrasted to the standard Kasteleyn transition where the density of defects grows continuously as the square-root of the distance to the critical temperature. The implications of this quantized Kasteleyn transition for the phase diagram of the model with finite couplings will be discussed.

*Speaker

sciencesconf.org:aqumics:604740

I7

Flexible Tensor Networks for Simulating Irregular Many-Body Systems

Sukhbinder Singh

Multiverse Computing, Spadina Ave., Toronto, Ontario M5T 2C2, Canada

Abstract

Tensor networks have emerged as indispensable tools for studying strongly correlated many-body systems. Matrix Product States (MPS) excel at simulating one-dimensional quantum systems, while Projected Entangled Pair States (PEPS) have advanced the understanding of higher-dimensional systems, those with topological order, quantum spin liquids, amongst others. However, these approaches are traditionally confined to regular, low-dimensional lattices, leaving many important models out of reach, such as spin glasses and quantum chemistry models that are often studied on irregular, densely connected graphs. In this talk, I will demonstrate how MPS and PEPS can be adapted to tackle such models. A key aspect of our algorithm is that it can dynamically reshape the geometry of the tensor network to align with the (unknown) low-energy correlation structure of the system [1]. I will present benchmarking results for simulations of spin glasses, simulated quantum annealing, disordered spin systems, and even regular 2D lattice systems, including the recent IBM kicked Ising experiment on the heavy-hexagon lattice [2].

[1] Projected Entangled Pair States with flexible geometry, Phys. Rev. Research 7, L012002 (2025)
[2] Efficient tensor network simulation of IBM's largest quantum processors, Phys. Rev. Research 6, 013326 (2024)

Speaker: Sukhi Singh

I8

Negative thermal expansion in the plateau state of a magnetically-frustrated spinel

Karlo Penc*[1]

[1]HUN-REN Wigner Research Centre for Physics, Budapest – Hungary

Abstract

CdCr2O4 is a frustrated magnetic insulator featuring a large one-half magnetization plateau. The plateau arises from lattice deformations that relieve frustration, which can be seen experimentally through magnetostriction. At the onset of this plateau, a large negative thermal expansion appears (Rossi et al., Phys. Rev. Lett. 123, 027205 (2019)). On the experimental side, dilatometry provides a precise phase diagram in a magnetic field of up to 30 Tesla. These measurements revealed a large negative thermal expansion associated with the collinear half-magnetization plateau for magnetic fields above 27 Tesla. Comparisons with a microscopic spin-lattice coupling theory reveal that this effect stems from a strong, temperature-dependent drop in magnetization caused by a nearly localized band of spin excitations in the plateau phase. Finally, I discuss how these findings relate to the magnetocaloric effect.

*Speaker

I9

Toroidal magnetic molecules for quantum information

Juergen Schnack*[1]

[1]Bielefeld University – Germany

Abstract

Toroidal magnetic molecules show vanishing magnetization at small fields as well as two toriodal orientations. The first property minimizes magnetic crosstalk whereas the second could potentially be exploited for storage. In addition, superpositions of such states might be usable for quantum computing.
I am going to review the known properties of toroidal magnetic molecules and discuss pros and cons of their employability in future quantum technology as well as unexpected findings.

*Speaker

sciencesconf.org:aqumics:601799

I10

Thermodynamics of the spin-1/2 Heisenberg antiferromagnet on the star lattice

Adrien Reingruber[1], Nils Caci[2], S. Wessel[3], Johannes Richter[4,5]

[1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany
[2]Laboratoire Kastler Brossel, Collège de France, CNRS, École Normale Supérieure - Université PSL, Sorbonne Université, 75005 Paris, France
[3]Institute for Theoretical Solid State Physics, RWTH Aachen University, 52056 Aachen, Germany
[4]Institut für Physik, Universität Magdeburg, P.O. Box 4120, 39016 Magdeburg,Germany
[5]Max-Planck-Institut für Physik Komplexer Systeme, Nöthnitzer Str. 38, 011087 Dresden, Germany

Abstract

Using a combination of quantum Monte Carlo simulations in adapted cluster bases, the finite temperature Lanczos method, and an effective Hamiltonian approach, we explore the thermodynamic properties of the spin-1/2 Heisenberg antiferromagnet on the star lattice. We consider various parameter regimes on this strongly frustrated Archimedean lattice, including the case of homogeneous couplings as well as the distinct parameter regimes of dominant vs. weak dimer coupling. For the latter case, we also explore the quantum phase diagram in the presence of inhomogeneous trimer couplings, preserving the inversion symmetry. We compare the efficiency of different cluster decoupling schemes for the quantum Monte Carlo simulations in terms of the sign problem, and relate our findings to previous results from tensor-network calculations regarding a valence bond crystal phase in the regime of weak dimer coupling.

Speaker: S. Wessel

I11

FRACTIONAL TOPOLOGICAL EXCITATIONS IN THE KAGOME-LATTICE HEISENBERG ANTIFERROMAGNET

Mike Zhitomirsky*[1]

[1]Institut Recherche Interdisciplinaire de Grenoble – CEA – France

Abstract

The classical Heisenberg antiferromagnet on a kagome lattice has attracted attention since the early 1990s (1,2). Realized, for example, in jarosites (3), this frustrated spin model presents a paradigmatic example of the order by disorder effect. We report new Monte Carlo results for the kagome antiferromagnet on periodic clusters with $N = 3L2$ spins and linear dimensions up to $L = 180$ (4). By studying large spin clusters we were able to resolve an anomaly in the specific heat at T^*/J ˜ 0.002. This anomaly is related to the Kosterlitz-Thouless transition in the XXZ spin model with weak planar anisotropy. We attribute the anomaly at T^* to the proliferation of fractional vortices, which exist in the kagome antiferromagnet even in the isotropic Heisenberg limit.

References

(1) J.T. Chalker, P.C.W. Holdsworth, E.F. Shender, Phys. Rev. Lett. **68**, 855 (1992).

(2) I. Ritchey, P. Chandra, P. Coleman, Phys. Rev. B **47**, 15342 (1993).

(3) B. Fåk, F.C. Coomer, A. Harrison, D. Visser, M.E. Zhitomirsky, EPL **81**, 17006 (2008).

(4) M. E. Zhitomirsky, e-print arXiv: (2025).

*Speaker

Oral presentations

(20 min. talk + 5 min. discussion)

O1

Fingerprints of field-induced Berezinskii–Kosterlitz–Thouless transition in Cu(C6H2(COO)4)(C2H5NH3)2 – A quasi-two-dimensional S = 1/2 antiferromagnet on rectangular lattice

Robert Tarasenko*[1], Illia Kozin[1], Alzbeta Orendacova[1], Erik Cizmar[1], Vladimir Tkac[1], and Martin Orendac[1]

[1]P.J. Safarik University – Slovakia

Abstract

The previous analysis of specific heat, magnetic susceptibility and magnetization identified the studied compound Cu(C6H2(COO)4)(C2H5NH3)2 as a quasi-two-dimensional S = 1/2 Heisenberg antiferromagnet on the rectangular lattice with the intrachain coupling $J1/kB \approx 10$ K and the interaction ratio $R \approx 0.7$. No transition to the magnetically ordered state was observed at temperatures down to 1.8 K (1). In this work, we focused on the analysis of specific heat at temperatures down to 0.4 K in magnetic fields up to 9 T. Specific heat measurements of powder sample pressed in the form of a pellet were performed in a commercial Physical Property Measurement System (PPMS) using the relaxation method. The specific heat studies in zero magnetic field did not show a phase transition to long-range magnetic order. Tracking the position of the peak in the temperature dependence of the difference between the specific heat in the finite and zero magnetic field, the phase diagram for Cu(C6H2(COO)4)(C2H5NH3)2 was constructed. The constructed phase diagram was compared with the theoretical prediction for the field induced Berezinskii–Kosterlitz–Thouless (BKT) transition predicted for S = 1/2 Heisenberg antiferromagnet on the square lattice. It should be noted that the transition temperatures for Cu(C6H2(COO)4)(C2H5NH3)2 are higher than BKT temperatures for a square lattice. This observation should be ascribed to the effect of interlayer interactions. The features characteristic for a field-induced BKT transition in studied system were confirmed by analysis of the magnetic field dependence of the entropy associated with the dissociation of bound vortex-antivortex pairs.
The work was supported by the projects APVV-22-0172 and VEGA 1/0132/22.
(1) R. Nath et al, Phys. Rev. B 91, 054409 (2015).

*Speaker

sciencesconf.org:aqumics:601654

O2

Voltage-controlled magnetism driven by electrical triggering of a metal-insulator transition

Lorenzo Fratino

Laboratoire de Physique Théorique et Modélisation, CY Cergy Paris Université

Abstract

Naturally occurring phase separation often has a prominent impact on magnetic and magnetotransport properties in strongly correlated electronic systems, such as rare-earth manganites. This talk will present examples of how the volatile resistive switching in metal-insulator transition (MIT) materials, a phenomenon where applied voltage drives a large resistance change, enables creating and tuning artificial phase separation by electrical means. The MIT switching commonly occurs by the formation of characteristic local spatial patterns, e.g., longitudinal conducting filaments or transverse insulating barriers, which effectively results in the injection of a different electronic and magnetic phase into the otherwise homogeneous material. In a model system (La,Sr)MnO 3 , an above threshold voltage triggers the intrinsic MIT due to the electrothermal effects and produces a phase-separated configuration in which a paramagnetic insulating barrier splits the ferromagnetic metallic matrix [1]. While magneto-optical studies showed that magnetic phase regions are well delineated, microdiffraction experiments revealed an inhomogeneous strain development throughout the entire device, suggesting that the applied voltage induces a highly nonuniform temperature profile. Electrical control of the electronic, magnetic, thermal and structural nonuniformities allows tuning of the magnetic properties in the MIT switching devices. In-operando magneto-optical and transport measurements revealed voltage-triggered easy-plane to uniaxial magnetic anisotropy switching [2] and multiple magnetoresistance anomalies including a large increase in magnitude and a sign flip of anisotropic and colossal magnetoresistance. Additionally, to include more flexibility and tunability, we developed a hybrid optoelectronic heterostructure that uses photocarrier injection from cadmium sulfide (CdS) to an LSMO layer to change its electrical conductivity. LSMO exhibits no significant optical response; however, the CdS/LSMO heterostructures show an enhanced conductivity, with a resistance drop of about 37These works demonstrate a unique approach to achieve voltage-controlled magnetism and introduces MIT switching materials as a nonlinear electrical platform to explore magneto-thermal phenomena.

[1] P. Salev, L. Fratino, et. al., Nat. Commun. 12, 5499 (2021).
[2] Salev, P., Fratino, et. al., Phys.Rev.B, 108(17), 174434 (2023).
[3] Navarro, H., Basaran, A. C., Ajejas, F., Fratino, L.et al. , Phys. Rev. App., 19(4), 044077 (2023).

Speaker: Lorenzo Fratino

O3

Analysis of magnetism in monolayer graphene near 1/4 doping

Maxime Lucas*[1], Andreas Honecker[1], and Guy Trambly De Laissardière[1]

[1]CY Cergy Paris Université – LPTM – France

Abstract

Recent studies of twisted bilayer graphene (or other 2D materials) have been stimulated by the discovery of correlations between electronic flatband states due to a moiré pattern (1). 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 (2), but unlike other lattices (3) its magnetic properties beyond half filling are mostly unexplored, except at 1/4 doping (4). Here, we present our analysis of graphene magnetism using a combination of the Hubbard model and MFT. We work at density values around 1/4 doping (average number of electron per site Ne=0.75) as it puts the system right into one of the Van Hove singularities found in graphene's density of states, giving rise to interesting magnetic properties. We present an interaction-density phase diagram and its associated magnetic orders, described by their band structure and spin structure factor.

(1) Y. Cao et al., Nature 556, 43 (2018); Nature 556, 80 (2018).
(2) M. Raczkowski et al., Phys. Rev. B 101, 125103 (2020), and Refs. therein.
(3) R. Scholle et al., Phys. Rev. B 108, 035139 (2023)
(4) S. Jiang, A. Mesaros, Y. Ran, Phys. Rev. X 4, 031040 (2014)

*Speaker

sciencesconf.org:aqumics:603824

O4

Magnetic properties of frustrated fcc oxides with general formula A2GdMO6 (A=Ba, Sr, Ca; M=Sb, Nb) for cryogenic refrigeration

Fiamma Berardi*[1], Eliseanne Koskelo[2], Liam Nagle-Cocco[1], Cheng Liu[1], Henry Fischer[3], and Sian Dutton[1]

[1]University of Cambridge [UK] – United Kingdom
[2]Department of Physics [Harvard University] – United States
[3]Institut Laue-Langevin (ILL) – ILL – 6, rue Jules Horowitz BP 156 38042 Grenoble Cedex 9, France

Abstract

Solid-state cooling is gaining scientific interest as a valuable alternative to cryogenic vapour-compression refrigeration, which relies on helium. Currently, 4He and 3He are used to reach extremely low temperatures (T≅2 K and T< 2 K, respectively), essential for many modern technologies, such as nuclear magnetic resonance, magnetic resonance imaging, and quantum computing. However, helium is increasingly becoming scarce and expensive. The magnetocaloric, electrocaloric, mechanocaloric and barocaloric effects are all investigated in the research field of solid-state refrigeration. Magnetocaloric refrigeration based on the magnetocaloric effect (MCE) is the most investigated cooling alternative to standard vapour-compression because of its high energy efficiency. An ideal magnetocaloric material for cryogenic applications would have suppressed magnetic ordering temperature and high density of spins with a large magnetic moment in order to maximise the entropy change. Magnetically frustrated compounds are promising candidates for solid-state refrigeration because of their suppressed ordering temperatures, large ground state entropy, and minimal nearest-neighbour (*nn*) spin interactions. Gadolinium oxides with a double perovskite structure in frustrated *fcc* lattices remain a relatively new field of research and are less investigated than the garnet and pyrochlore lattice analogues. Here we aim to investigate the role of *d0* and *d10* ions on the lanthanide superexchange by comparing the performances of two families of *fcc* gadolinium oxides: *A*2GdNbO6 and *A*2GdSbO6 (*A*={Ba, Sr, Ca}). Zero field cooled (ZFC) magnetic susceptibility measurements on *A*2GdNbO6 compounds show no evidence of magnetic ordering down to 1.8 K, indicating minimal short-range correlations. The compounds adhere well to the predicted Curie-Weiss behaviour for free uncoupled spins, with small ferromagnetic (Ba2GdNbO6) and antiferromagnetic (Sr2GdNbO6 and Ca2GdNbO6) deviations. Neutron magnetic pair distribution function (mPDF) analysis of Ba2GdSbO6 allowed to identify the AFM and FM Gd-Gd interactions in the sample, showing that short-range correlations are still weak at 3.1 K and long-range order is suppressed. The overall results suggest that *fcc* gadolinium oxides are promising materials for magnetocaloric cryogenic refrigeration.

*Speaker

sciencesconf.org:aqumics:597215

O5

Easy-axis Heisenberg model on the triangular lattice: from supersolid to gapped solid

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[4]Department of Applied Physics, Tokyo University of Science – Japan
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Abstract

Motivated by recent experiments, we study the anisotropic easy-axis spin-1/2 Heisenberg model on the triangular lattice. Thermodynamic properties already revealed a qualitative crossover in the large anisotropy regime, in particular the Wilson ratio shifts from diverging to vanishing. We discuss the supersolid scenario at large anisotropy through the dynamical structure factor, which notably deviates from the linear spin-wave theory. Finally, we present numerical evidence for a vanishing supersolid order parameter consistent with a magnetic gap.

*Speaker

sciencesconf.org:aqumics:601823

O6

Quantum magnetism of the anisotropic kagome antiferromagnet Y-kapellasite

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Abstract

The kagome lattice occupies a central place in the field of magnetic frustration. Very early on, pioneering theoretical studies on the kagome Heisenberg antiferromagnetic (KHAF) model highlighted its specificity even at a classical level. Since then, it has become a prime candidate for stabilizing a quantum spin liquid in real materials. In this presentation, I will introduce our recent results on the quantum anisotropic kagome Heisenberg antiferromagnet Y-kapellasite Y3Cu9(OH)19Cl8. There, three different nearest neighbor interactions yield a rich phase diagram, which features a large spin liquid phase . besides two long range ordered ones. Noticeably the large difference in the Y and Cu radii prevents inter-site mixing and the anisotropic kagome planes are free from magnetic defects. I present a detailed investigation of large, phase pure, single crystals of this compound by neutron scattering, and local μSR and NMR techniques. Our study of single crystals gives evidence for a bulk magnetic transition at 2.1 K. Our analysis locates Y-kapellasite closer to the phase boundary to the spin-liquid phase than expected from ab initio calculations, where enhanced quantum fluctuations drastically reduced the ordered moment of the Cu2+.

*Speaker

O7

Entanglement in Tensor Networks

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Abstract

We analyze two representations of the tensor networks: (1) the *vertex* representation commonly used to approximate quantum states and (2) the *weight* representation known from classical statistical mechanics. We test them both on classical spin systems since they have equivalent partition functions. Despite all thermodynamic quantities being equivalent for both representations, entanglement entropy is always lower for the vertex representations for finite and infinite systems, irrespective of the spin model, number of spin degrees of freedom, and the underlying lattice geometry. We investigate various types of tensor networks to reason why eigenvalues of the reduced density matrices decrease faster for the vertex representation. Such discrepancy endures within the entire temperature region, including those phase transition temperatures where models exhibit logarithmic divergence of the entanglement entropy in the continuous phase transitions, even in the discontinuous phase transitions.

*Speaker

O8

Adiabatic demagnetization refrigeration in the vicinity of magnetic ordering

Anton Jesche*[1], Anna Klinger[1], Marvin Klinger[1], Tim Treu[1], and Philipp Gegenwart[1]

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Abstract

Recent advances in the development of novel ADR coolants have introduced a variety of materials, particularly magnetically frustrated systems. These materials are expected to enable lower ordering temperatures, potentially achieving the lowest temperatures in ADR cooling processes. This presentation will review a selection of Yb- and Gd-based materials (1).
A specific focus will be placed on antiferromagnetic (AFM) ordering and its impact on the cooling and heating processes under adiabatic conditions. The field- and temperature-dependence of entropy near AFM ordering will be discussed, based on detailed measurements of NaGdPO (2). The potential advantages of AFM ordering, particularly in the context of precooling stages, will also be examined, highlighting its contributions to improving ADR efficiency.
(1) Treu et al., J. Phys.: Condens. Matter 37 (2025) 013001
(2) Telang et al., arXiv:2411.04805

*Speaker

C

From High-Spin Complexes to Magnetic Dendrimers

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Abstract

Giant spin molecules and photomagnetic compounds are gaining increasing attention due to their potential application in magnetocaloric devices or optical switches. In this context, polycyanometallate precursors can be considered as valuable building blocks, not only for the design of high spin molecules, or for enhancing their magnetization through visible light irradiation, but also for the design and the synthesis of multicomponent architectures.

In this presentation, we focus on three key themes that emerge from our research:
- High spin molecules based on polycyanometallates precursors viewed as interesting nanomagnets. The importance of anisotropy for slow relaxation magnetization will be discuss as well in the frame of Single Molecule Magnet (SMM) design.
- A family of photo switchable compounds (MoCu6, Mo6Cu14) that have been fully characterized using various techniques (XRD, SQUID, EPR, EXAFS, XMCD, …) to gain better understanding of the photo-magnetic processes which may vary between compounds (e. g. spin transition, electron transfer, bond breaking).
- A family of magnetic dendrimers based on polyoxalato complexes opening a new area of research for the design of polynuclear complexes with tailored properties.

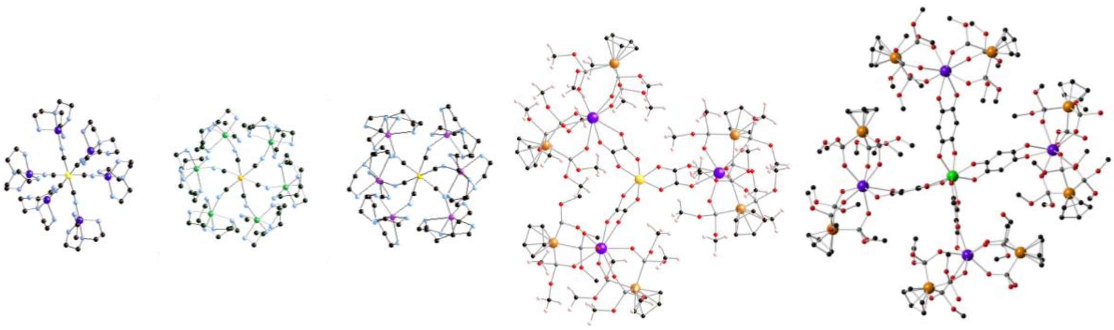

Fig. 1 : CrCu6, CrCu6, CrMn6, CrGd3Co6 and ZrTb4Co8 (X-ray structures)

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O9

Large-Scale Magnetic Cooling for Quantum Computing

Steffen Säubert*[1]

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Abstract

As quantum computing approaches large-scale deployment, achieving ultra-low temperatures efficiently and reliably has become paramount. A promising solution is to scale adiabatic demagnetization refrigeration (ADR), a technique capable of reaching millikelvin temperatures without requiring cryogenic liquids, most notably a technology independent of helium-3. We present a breakthrough, achieving sub-30mK temperatures continuously with ADR, paving the way for future quantum computing platforms. Our primary objective is to enhance critical ADR components, including mechanical and superconducting heat switches, magnet and cooling media design as well as the exploration of novel refrigerants. These components are essential to improve cooling performance, both in temperature and cooling power, and ensure scalability. This presentation will cover ongoing research and innovative approaches across these domains, drawing on materials science, thermal management, and superconducting technology to advance ADR systems. By refining these fundamental technologies, ADR offers a scalable solution, positioning magnetic cooling as a vital platform for the next generation of quantum computing.

*Speaker

sciencesconf.org:aqumics:601157

O10

Thermal or quantum phase transition in a deformable spin-1/2 Ising chain in a longitudinal or transverse magnetic field

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[2]Pavol Jozef Safarik University in Kosice – Slovakia

Abstract

Thanks to the relatively simple nature of spin chains, we are able, in some cases, to precisely study various phenomena related to magnetic-field-driven phase transitions. In the present work, we will investigate a deformable spin-1/2 Ising chain either in a transverse or longitudinal magnetic field accounting for the magnetoelastic coupling with an exchange interaction linearly dependent on a lattice distortion. These deformable Ising spin chains were already studied at zero temperature (1), whereby the antiferromagnetic spin-1/2 Ising chain in a longitudinal (transverse) magnetic field has been shown to display a first-order (second-order) phase transition accompanied with a discontinuous (continuous) behavior of the inverse compressibility. On the other hand, the magnetoelastic features of the deformable spin-1/2 Ising chains in the longitudinal and transverse magnetic field remain unexplored at non-zero temperature yet. While the deformable spin-1/2 Ising chain in a longitudinal magnetic field is tractable within the transfer-matrix method, the deformable spin-1/2 Ising chain in a transverse magnetic field can be treated by combining Jordan-Wigner fermionization, Fourier transformation, and Bogoliubov transformation. The main outcome of both these calculation procedures is the variational Gibbs free energy, which is subsequently minimized with respect to a distortion parameter. By minimizing the Gibbs free energy, we calculated the magnetization, the mean displacement and inverse compressibility of both investigated deformable Ising chains. The resulting magnetization curve of the deformable spin-1/2 Ising chain in the longitudinal magnetic field exhibits at low but non-zero temperature a magnetic hysteresis, while no hysteresis is observed in the relevant magnetization curve of the deformable spin-1/2 Ising chain in the transverse magnetic field. The critical temperature, at which the discontinuous phase transition of the deformable spin-1/2 Ising chain in the longitudinal magnetic field changes to the continuous one, is calculated as a function of the external magnetic field or pressure. (1) O. Derzhko, J. Strečka, L. Gálisová, Eur. Phys. J. B 86, 88 (2013)

*Speaker

sciencesconf.org:aqumics:599598

O11

Magnetic-field-driven rise and fall of a bipartite entanglement in a spin-liquid phase of a spin-1/2 Heisenberg branched chain

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Abstract

The spin-1/2 Heisenberg branched chain with the unit cell composed of three spins in the main backbone and one spin at a side branching of one-dimensional chain is investigated with the help of density-matrix renormalization group (DMRG) and quantum Monte Carlo (QMC) methods. The DMRG simulations were employed to calculate zero-temperature magnetization curves and to construct the ground-state phase diagram, which is composed from four different ground states classified as gapped zero-plateau and one-half plateau phase, a gapless spin-liquid phase and a fully saturated phase. It is shown that the one-half magnetization plateau vanishes at the Kosterlitz–Thouless quantum critical point, which is wedged into a parameter space of the gapless quantum spin-liquid phase. The bipartite quantum entanglement between four distinct nearest-neighbor pairs of the spin-1/2 Heisenberg branched chain is quantified through the concurrence. It is found that the concurrence varies continuously within the quantum spin-liquid phase, where it may display a continuous rise, a continuous fall or eventually an intriguing rise-and-fall behavior. On the contrary, the concurrence is kept constant within two gapful zero- and one-half plateau phases. Temperature and magnetic-field dependencies of the magnetization and magnetic susceptibility computed within the QMC method uncover clear signatures of the quantum critical point at finite temperatures.

*Speaker

O12

Enhancing fidelity in teleportation of a two-qubit state via a quantum communication channel formed by spin-1/2 Ising-Heisenberg trimer chains due to a magnetic field

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[3]University Ibn Tofail – Morocco

Abstract

We demonstrate that two independent spin-1/2 Ising-Heisenberg trimer chains provide an effective platform for the quantum teleportation of any entangled two-qubit state through the quantum communication channel formed by two Heisenberg dimers. The reliability of this quantum channel is assessed by comparing the concurrences, which quantify a strength of the bipartite entanglement of the initial input state and the readout output state. Additionally, we rigorously calculate quantities fidelity and average fidelity to evaluate the quality of the teleportation protocol depending on temperature and magnetic field. It is evidenced that the efficiency of quantum teleportation of arbitrary entangled two-qubit state through this quantum communication channel can be significantly enhanced by moderate magnetic fields. This enhancement can be attributed to the magnetic-field-driven transition from a quantum antiferromagnetic phase to a quantum ferrimagnetic phase, which supports realization of a fully entangled quantum channel suitable for efficient quantum teleportation. The polymeric trimer chains Cu3(P2O6OH)2 are proposed as an experimental resource of this quantum communication channel, which provides an efficient platform for realization of the quantum teleportation up to moderate temperatures 40 K and extremely high magnetic fields 80 T.

*Speaker

Posters

P1

Effect of a biquadratic exchange term on the thermal stability of genuine entanglement in a spin-1 Heisenberg trimer

Hana Vargova*[1] and Jozef Strečka[2]

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[2]University of Pavol Jozef Safarik, Fakulty of Science – Slovakia

Abstract

The impact of a biquadratic exchange term on the stability of entanglement has been analyzed in an isotropic spin-1 Heisenberg trimer. Specifically, the pairwise entanglement within each spin-1 dimer has been quantified using negativity as a function of an external magnetic field. Additionally, the genuine entanglement of the system has been assessed through the geometric average of all bipartite negativities in the full (non-reduced) trimeric system. Rigorous analytical calculations reveal that the biquadratic exchange term has a significant effect on the magnetic ground state and, consequently, influences the strength of quantum entanglement. At zero temperature, the spin-1 Heisenberg trimer exhibits genuine entanglement in each ferrimagnetic ground state, achieving saturated genuine entanglement under a sufficiently small magnetic field. Furthermore, it is found that the biquadratic exchange term mitigates the influence of thermal fluctuations, thereby stabilizing entanglement as the biquadratic exchange term increases.

*Speaker

sciencesconf.org:aqumics:601224

P2

Entanglement in Vertex Representation of Tensor Networks

Matej Moško*[1], Maria Polackova[2], Roman Krcmar[1], and Andrej Gendiar[1]

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[2]Higgs Centre for Theoretical Physics, School of Physics and Astronomy, The University of Edinburgh – United Kingdom

Abstract

We propose a vertex representation of tensor networks for classical spin systems on a set of hyperbolic lattices, the square lattice included (arXiv:2406.03426). Calculating multiple thermodynamic quantities for multi-state spin systems, we classify the phase transitions of the first, second, and infinite order. We compare the results calculated by the vertex representation using the bond degrees of freedom with the results calculated by the weight representation using the physical spin degrees of freedom instead. We demonstrate that the vertex representation captures less entanglement.

*Speaker

P3

Hubbard Model: From Paramagnetism to Antiferromagnetism via slave spin approach

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

[1]LPTM – LPTM – France

Abstract

My project focuses on numerical simulations of strongly correlated systems, using the slave
spin mean field approach. I have studied the paramagnetic phase of the half-filled two-dimensional Hubbard model on bethe, square and triangular lattices, where we observed a metal-insulator transition. This transition is driven by the interplay between kinetic energy, which promotes electron delocalization, and interaction (Coulomb repulsion) energy, which favors electron localization. I also investigated the effect of doping the system, finding that it remains metallic. Building on this work, I explored the impact of introducing next nearest neighbor hopping to the model, which initially considered only nearest neighbor interactions.

Recently, I began studying the antiferromagnetic phase of the same model, aiming to investigate it for different lattice geometries and explore the effect of doping on the occurrence of antiferromagnetism. This also includes examining the geometric frustration introduced by next nearest neighbor hopping, similar to what was done in the paramagnetic case, to understand its impact on the system.

As a next step, I plan to extend these calculations to multiband systems, which will provide the groundwork for applying this study to real materials.

*Speaker

sciencesconf.org:aqumics:601311

P4

Non-unitary local disentanglers

Roman Krcmar*[1], Matej Mosko[1], Tomotoshi Nishino[2], and Andrej Gendiar[1]

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[2]Kobe University – Japan

Abstract

Translating classical partition function of the Ising model into tensor network can be done by using Interaction Round the Face (IRF) formulation or vertex formulation. While equivqlent, they produce different classical analoques of entanglement entropy calculated from density matrix. One possible explanation of this difference is by application of the transformation of the corner transfer matrix by means of the non-unitary local operators.

*Speaker

P5

Room-Temperature Entanglement of the Nickel-Radical Molecular Complex (Et3NH)(Ni(hfac)2L) Reinforced by the Magnetic Field

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Abstract

The behavior of bipartite entanglement in the nickel-radical molecular complex (Et3NH)(Ni(hfac)2L), where HL denotes 2-(2-hydroxy-3-methoxy-5-nitrophenyl)-4,4,5,5-tetramethyl-4,5-dihydro-1H-imidazol-3-oxide-1-oxyl and hfacH stands for hexafluoroacetylacetone, is investigated in detail. This molecular compound, characterized by significant isotropic exchange coupling (J/kB = 505 K) and distinct g-factors (gRad = 2.005 and gNi = 2.275), can be modeled as a spin-(1,1/2) Heisenberg dimer comprising a spin-1 Ni2+ magnetic ion and a spin-1/2 nitronyl-nitroxide radical. The sizable energy gap between the ground (doublet) and excited (quartet) states suggests its suitability as a potential molecular qubit for practical applications. Notably, this study demonstrates that the complex exhibits robust bipartite entanglement at temperatures exceeding room temperature, achieving approximately 40% of the maximum (Bell state) entanglement, irrespective of currently attainable magnetic field strengths. This remarkable feature positions the (Et3NH)(Ni(hfac)2L) complex as a promising candidate for implementing molecular qubits in room-temperature quantum computing and information processing applications, including data storage and quantum gates.

*Speaker

sciencesconf.org:aqumics:601130

P6

Simulation, optimization and design of an adiabatic demagnetization refrigeration system for temperatures below 2 K.

Jorginho Villar Guerrero*[1], Marvin Klinger*[2], and Anna Klinger[2]

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[2]Universität Augsburg [Augsburg] – Germany

Abstract

Designing and testing cryogenic systems traditionally requires significant time and resources, limiting opportunities for rapid prototyping and iterative development. We present a simulation and optimization of an ADR upgrade for the Quantum Design Physical Property Measurement System (PPMS®). The framework integrates concurrent numerical thermal conduction and radiation analysis with computer-aided engineering (CAE) capabilities, enabling rapid iteration of critical components including thermal links, insulation, and shielding systems. Residual gas transport in a high vacuum system and magnetic eddy heating were also investigated. To validate the results, the numerical data were compared with the empirically collected data to confirm their accuracy.

*Speaker

sciencesconf.org:aqumics:595119

P7

Spin-1/2 quantum anisotropic Heisenberg model with magnetoelastic interaction

Michal Jaščur[1] and Majid Moradi*[2]

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[2]Institute of Physics, P.J. Šafárik University in Košice – Slovakia

Abstract

In this contribution, we have investigated the spin-1/2 quantum anisotropic XX Heisenberg model, enriched by the inclusion of magnetoelastic coupling. The total Helmholtz free energy of the system comprises three principal contributions: the static lattice energy, the energy of lattice vibrations and the magnetic energy. The static lattice energy is modeled using the Morse potential, explicitly dependent on the relative volume change, ϵ = (V - V)/V, where V represents the system's volume at T = 0. The vibrational energy, also dependent on ϵ, is described by a Grüneisen modification of the Einstein harmonic phonons energy. Finally, the magnetic energy was calculated using the standard Oguchi pair approximation, assuming nearest-neighbors exchange interactions that decrease exponentially with increasing ϵ. Beyond thermodynamic quantities, the total energy depends on several parameters, which are naturally incorporated into the definitions of partial energy contributions. By adjusting these parameters, we can modify the strength of the magnetoelastic coupling and explore various magnetic phenomena. The primary objective of this work is to present numerical results for thermal phase diagrams and temperature dependencies of relevant physical quantities for the model on a simple cubic lattice. The influence of magnetoelastic coupling on the system's critical boundaries will be elucidated in detail.

*Speaker

sciencesconf.org:aqumics:602081

P8

Sub-50mK adiabatic demagnetization refrigeration with frustrated Yb-oxide magnets as an upgrade for the PPMS®

Marvin Klinger*[1], Anna Klinger*[1], and Philipp Gegenwart[1]

[1]Universität Augsburg [Augsburg] – Germany

Abstract

Accessing temperatures in the millikelvin (mK) regime is a prerequisite for quantum-matter research and quantum technologies. Adiabatic demagnetization refrigeration (ADR) is a simple and sustainable alternative to dilution refrigeration. We have shown recently, that geometrically frustrated Yb-oxides feature significant advantages compared to the traditionally utilized hydrated paramagnetic salts for mK-ADR (1,2).
We developed an upgrade for the Quantum Design Physical Property Measurement System (PPMS®) that employs ADR to achieve temperatures well below 50 mK for multiple hours. The upgrade consists of a user-friendly insert that integrates seamlessly with existing PPMS® systems. Its modular design allows researchers to easily swap the low-temperature assembly to accommodate different experimental needs, currently supporting electrical transport, stress/strain, and heat capacity measurements.
This versatility and accessibility can make sub-50mK measurements available to a broader scientific community without the complexity of dilution refrigeration. (1) Y. Tokiwa et al., Commun. Mater. 2 (2021) 42.
(2) T. Treu et al., J. Phys. Condens. Matter 37, 013001 (2025).

*Speaker

P9

Ground-state degeneracy and magneto-thermodynamics of the spin-½ Heisenberg antiferromagnet on the diamond-decorated square lattice

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[2]Institute of Physics, Faculty of Science, P. J. Šafárik University, Park Angelinum 9, 04001 Košice, Slovakia

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[4]Institute for Theoretical Solid State Physics, JARA FIT, and JARA CSD, RWTH AachenUniversity, 52056 Aachen, Germany

[5]Laboratoire Kastler Brossel, École Normale Supérieure – Université PSL, CNRS, Sorbonne Université, Collége de France, 75005 Paris, France

Abstract

The spin-½ Heisenberg antiferromagnet on the diamond-decorated square lattice is a highly frustrated quantum spin system that exhibits rich physical phenomena. In the presence of a magnetic field, it displays various quantum phases including the Lieb- Mattis ferrimagnetic, dimer-tetramer, monomer-dimer, and spin-canted phases, in addition to the trivial fully saturated state [1]. We investigate the thermodynamic properties of this model using several complementary analytical and numerical methods such as exact diagonalization up to systems of 40 spins, an effective monomer-dimer description, sign-problem-free quantum Monte Carlo simulations for up to 180 spins, and a decoupling approximation. In this contribution, we focus on the parameter region favoring the dimer-tetramer phase [2]. This ground state can be represented by a classical hard-dimer model on the square lattice and retains a macroscopic degeneracy even under a magnetic field. However, the description of the low-temperature thermodynamics close to the boundary between the macroscopically degenerate dimer-tetramer and the non-degenerate monomer-dimer phases requires an extended classical monomer-dimer lattice-gas model. In the vicinity of the dimer-tetramer phase, we detect an enhanced magnetocaloric effect promoting an efficient cooling to absolute zero temperature under adiabatic demagnetization.

[1] N. Çaçi, K. Karl'ová, T. Verkholyak, J. Strečka, S. Wessel, A. Honecker, Phases of the Spin-½ Heisenberg Antiferromagnet on the Diamond-Decorated Square Lattice in a Magnetic Field, Phys. Rev. B 107, 115143 (2023)

[2] K. Karl'ová, A. Honecker, N. Çaçi, S. Wessel, J. Strečka, T. Verkholyak, Thermodynamic Properties of the Macroscopically Degenerate Tetramer-Dimer Phase of the Spin-½ Heisenberg Model on the Diamond-Decorated Square Lattice, Phys. Rev. B 110, 214429 (2024)

Speaker: A. Honecker

P10

Kasteleyn phase transition in spin-1/2 Heisenberg diamond-like decorated honeycomb lattice

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Abstract

The spin-1/2 quantum Heisenberg model on the two-dimensional diamond-like decorated honeycomb lattice is a highly frustrated magnet exhibiting rich phenomena. While its isotropic version exhibits a macroscopically degenerate dimer-tetramer phase, a small distortion can completely lift the degeneracy, resulting in a dimer-tetramer crystal (DTC). Based on a mapping of the original quantum spin model onto a hard-dimer model on the hexagonal lattice, we predict a thermal phase transition above the DTC that belongs to the Kasteleyn universality class.

Speaker: K. Karľová