TT 50: Poster Session: Correlated Electrons 2

Time: Wednesday 15:00–18:30 Location: Poster D

TT 50.1 Wed 15:00 Poster D

Competing magnetic orders and spin liquids in three-dimensional quantum magnets — •Finn Lasse Buessen and Simon Trebst — Institute for Theoretical Physics, University of Cologne, 50937 Cologne, Germany

Quantum magnetism and the formation of quantum spin liquids remains one of the most intriguing aspects of contemporary solid-state physics, which is corroborated by the high research activity of experimentalists and theorists alike. Candidate materials to host spin-liquid behavior include a variety of two-dimensional compounds, but they also comprise three-dimensional structures. Only recently, interest was sparked by the discovery of spin liquid signatures in $NiRh_2O_4$, a three-dimensional material that realizes spin-1 moments on the diamond lattice with additional frustration mediated by next-nearest neighbor interactions. To complement experimental findings with appropriate theoretical understanding, an efficient methodological framework is vital that is capable of capturing quantum magnetism in three dimensions – a challenging regime, which is inaccessible to many conventional (both numerical and analytical) methods.

In this work, we report on recent methodological advances of the pseudofermion functional renormalization group (pf-FRG), which is suited to describe three-dimensional frustrated quantum magnetism even at finite temperatures, and leverage the method to model the interplay of magnetic order, quantum order-by-disorder, and spin liquids in $NiRh_2O_4$ as well as in other materials.

TT 50.2 Wed 15:00 Poster D

Interaction effects on surface flat bands in 3D Kitaev spin liquids — •Christoph Berke and Simon Trebst — Institut für theoretische Physik, Universität zu Köln

Frustrated quantum magnets can give rise to unconventional spin-liquid ground states. Paradigmatic examples are two- and three-dimensional Kitaev systems that exhibit gapless spin liquids which are best described as Majorana metals that, depending on the underlying lattice structure, exhibit Fermi surfaces, nodal lines or Weyl nodes. Here we will discuss the physics of nodal-line Kitaev spin liquids, which are protected by the particle-hole symmetry inherent to Majorana fermions. Our interest is particularly on the flat-band surface states that accompany these bulk nodal lines. We investigate instabilities of these highly degenerated bands arising from additional spin exchange terms which introduce interactions between the Majorana fermions.

TT 50.3 Wed 15:00 Poster D

Chiral spin liquid phase in a generalized Kitaev model — •Tim Eschmann, Vatsal Dwivedi, Ciarán Hickey, and Simon Trebst — Institute for Theoretical Physics, University of Cologne, Germany

In the field of frustrated magnets, chiral spin liquids are of particular interest for their realization of fractional quantum Hall physics in quantum lattice systems. In this poster, we will discuss the formation of a chiral spin liquid in a generalized Kitaev model on the Shastry-Sutherland lattice. Similar to the original solution for the Kitaev honeycomb model, this five-coordinated lattice allows for an exact solution where the original spin degrees of freedom fractionalize into Majorana fermions and a $\mathbb{Z}_2$ gauge field. Varying the coupling strengths one finds a variety of spin liquid phases, the most interesting one being a spin analog of a second-order topological insulator. Using large-scale sign-problem free quantum Monte Carlo simulations, we identify the thermodynamic signatures of these phases and show that the ordering of the $\mathbb{Z}_2$ gauge field occurs at a particularly high transition temperature.

TT 50.4 Wed 15:00 Poster D

One and two particle excitations in the Kitaev-Heisenberg bilayer — •Erik Wagner and Wolfram Brenig — Institute for Theoretical Physics, Technical UniversityBraunschweig, Braunschweig, Germany

We study the magnetism of a honeycomb Kitaev spin-model with (an-)isotropic intralayer exchange $J_{x,y,z}$, coupled by additional interlayer Heisenberg exchange J to form a bilayer. Starting from the limit of decoupled dimers we use a perturbative continuous unitary transformation (pCUT), based on the flow equation method, to perform series expansion to analyze the spectrum. In particular we consider the groundstate energy and one particle dispersion up to 9th order in $J_{x,y,z}$ as well as the two particle interactions and spectrum up to 6th order. Results for (anti-)bound states will be presented versus anisotropy and for various bilayer-stackings. Known results for the condensation of single particle states [1] will be contrasted to findings from the two particle sector.

[1] U.F.P. Seifert, J. Gritsch, E. Wagner, D.G. Joshi, W. Brenig, M. Vojta, K.P. Schmidt, Phys. Rev. B **98**, 155101 (2018)

TT 50.5 Wed 15:00 Poster D

Thermal transport in the anisotropic two-dimensional Kitaev spin liquid — •Angelo Pidatella[1], Alexandros Metavitsiadis[2], and Wolfram Brenig[2] — [1]Institut für Theoretische Physik, Technische Universität Dresden — [2]Institut für Theoretische Physik, Technische Universität Braunschweig

We investigate the longitudinal thermal transport of the two-dimensional Kitaev spin model on the honeycomb lattice, focusing on the role of anisotropic exchange to cover either gapless or gapped phases of the model. Combining exact diagonalization on small systems with an average gauge configuration approach for up to $\sim O(10^4)$ spinful sites, we report our findings for the thermodynamic properties, the dynamical energy current auto-correlation function, as well as the static dc heat conductivity, over a wide range of temperatures and exchange anisotropies. We find that, despite a thermal gauge-disorder induced pseudogap in the correlation spectra on finite systems, and regardless of the anisotropy, both phases feature normal dissipative transport in the thermodynamic limit, with a low-temperature dependence crossing over from power law to exponentially activated behavior upon entering the gapped phase.

TT 50.6 Wed 15:00 Poster D

Magnetic properties of the Breathing Kagome Lattice $S = 1/2$ XY Model with Four-Site Ring Exchange — •Niklas Casper and Wolfram Brenig — Institute for Theoretical Physics, Technical University Braunschweig, Germany

We study the magnetic properties of the breathing kagome lattice $S = 1/2$ XY model with four-site ring exchange. In this trimerized variation, spins which belong to upward or downward facing triangles have different coupling strengths. This model may be of relevance to synthesized vanadium oxyfluoride compound $[NH_4]_2[C_7H_{14}N][V_7O_6F_{18}]$ (DQVOF). Even though it is a frustrated quantum spin model, it does not suffer from the infamous sign problem and can be treated by Quantum Monte Carlo (QMC). In particular, we use the stochastic series expansion (SSE) method which is extended by including a four-site ring exchange term that flips spins on a square plaquette using an update procedure proposed by [1]. Results for thermodynamic properties as well as the structure factor will be presented.

[1] R. G. Melko and A. W. Sandvik, Phys. Rev. E **72**, 026702

TT 50.7 Wed 15:00 Poster D

RIXS on $Ba_3CeIr_2O_9$: an inelastic incarnation of Young's double-slit experiment — •Alessandro Revelli[1], Marco Moretti Sala[2], Giulio Monaco[3], Petra Becker[4], Maria Hermanns[5], Philipp Warzanowski[1], Paul van Loosdrecht[1], Daniel Khomskii[1], Jeroen van den Brink[6], and Markus Grüninger[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]ESRF, Grenoble, France — [3]Universita di Trento, Italy — [4]Abt. Kristallographie, Institut fur Geologie und Mineralogie, Universitat zu Köln, Germany — [5]Stockholm University, Sweden — [6]IFW Dresden

Young's archetypal double-slit experiment forms the basis for modern diffraction techniques. We report on an inelastic incarnation of Young's experiment and demonstrate that resonant inelastic x-ray scattering (RIXS) measures interference patterns which reveal the symmetry and character of electronic excited states in the same way as elastic scattering does for the ground state. A prototypical example is provided by the quasi-molecular electronic structure of insulating $Ba_3CeIr_2O_9$ with face-sharing IrO_6 octahedra forming structural Ir dimers. The double 'slits' in this resonant experiment are the highly localized core levels of the two Ir atoms within a dimer. The clear double-slit-type sinusoidal interference patterns that we observe allow us to characterize the electronic excitations. The physics is well described by quasi-molecular

orbitals. The ground state shows a spin-orbit-entangled $j = 0$ singlet predominantly built from $j = 1/2$ moments with the corresponding triplet excitation lying at an extraordinarily large energy of 1.2 eV.
[1] A. Revelli *et al.*, Science Advances, in press (2018).

TT 50.8 Wed 15:00 Poster D

j=1/2 moments on the fcc lattice in Ba_2CeIrO_6 — Alessandro Revelli[1], •Chin Chyi Loo[1], Marco Moretti Sala[2], Giulio Monaco[3], Tobias Fröhlich[1], Thomas Lorenz[1], Petra Becker[4], Ladislav Bohatý[4], Dominik Kiese[5], Finn Lasse Büssen[5], Jan Attig[5], Sergey Streltsov[6], Arun Paramekanti[7], Markus Braden[1], Simon Trebst[5], Paul van Loosdrecht[1], and Markus Grüninger[1] — [1]II. Physics Institute, University of Cologne — [2]ESRF, Grenoble, France — [3]Universita di Trento, Italy — [4]Sect. Crystallography, Institute of Geology and Mineralogy, University of Cologne — [5]Institute for Theoretical Physics, University of Cologne — [6]Russian Academy of Sciences, Ekaterinburg, Russia — [7]Department of Physics, University of Toronto, Canada

Spin-orbit-entangled j=1/2 iridates were predicted to host exotic quantum states, e.g. a Kitaev spin liquid. In real materials, deviations from cubic symmetry mix j=1/2 and 3/2 states, which may strongly affect the properties. We establish the double perovskite Ba_2CeIrO_6 as a nearly ideal model system for j=1/2 on an fcc lattice combining geometrical and exchange frustration. XRD finds an average cubic structure, while RIXS reveals the smallest crystal-field splitting observed thus far in $5d^5$ iridates, showing that the ground state has 98.4% j=1/2 character. Significant exchange interactions are supported by the large Curie-Weiss temperature, the dispersion of the j=3/2 states, and DFT results. We estimate the ratio of Kitaev to Heisenberg coupling as K/J=0.1-0.2. Magnetic order sets in at 14 K, while a theoretical study of the J_1-J_2-K model suggests that Ba_2CeIrO_6 is close to a spin liquid.

TT 50.9 Wed 15:00 Poster D

Crystal growth and magnetic characterization of novel kagome-type materials — •Christian Klein[1], Mahmoud Abdel-Hafiez[1,2], and Cornelius Krellner[1] — [1]Physikalisches Institut, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 1, D-60438 Frankfurt am Main — [2]Department of Physics, Harvard University, 17 Oxford Street, Cambridge, MA 02138

Kagome-lattices are promising materials to investigate frustrated quantum spin systems with a possible quantum spin liquid (QSL) ground state [1].

We report on synthesis and characterization of the spin-1/2 antiferromagnet material Barlowite ($Cu_4(OH)_6BrF$) and the isostructural Cl-analogue Claringbullite ($Cu_4(OH)_6ClF$). The kagome-layers are build up by copper ions and separated from each other through a transition-metal cation, so that a quasi-two-dimensional system is created [2]. Substitution with a non-magnetic ion on the interlayer position leads to a magnetic decoupling between the kagome layers. The synthesis was carried out under hydrothermal conditions [3]. Single Crystals of Claringbullite were obtained as well as polycrystalline samples of the Zn-doped Barlowite. Characterization of the samples was done by x-ray diffraction, energy dispersive x-ray analysis and thermodynamic measurements for determining the magnetic ground state of these samples and its dependence on the respective substitution level.
[1] P. A. Lee, Science 321, 1306 (2008)
[2] H. Jeschke et al., PRB 92, 094417, (2015)
[3] R. Smaha et al., J. Solid State Chem. 268, 123 (2018)

TT 50.10 Wed 15:00 Poster D

Kagome quantum spin systems in the atacamite family — Pascal Puphal[1], •Katharina M. Zoch[1], Joy Désor[1], Michael Bolte[2], and Cornelius Krellner[1] — [1]Physikalisches Institut, Goethe-Universität Frankfurt, 60438 Frankfurt am Main, Germany — [2]Institut für Organische Chemie der Universität Frankfurt, 60439 Frankfurt am Main, Germany

The atacamite family of compounds presents a rich field of different substitution possibilities based on the three basic polymorphs of $Cu_2(OH)_3Cl$: atacamite, clinoatacamite and botallackite, allowing substitutions both on the Cu and Cl place. We present the hydrothermal synthesis, as well as structural and chemical analysis, of single crystals of $EuCu_3(OH)_6Cl_3$, $Zn_xCu_{4-x}(OH)_6(NO_3)_2$ and haydeeite, and $MgCu_3(OH)_6Cl_2$ compounds, all arising from the atacamite family [1]. Magnetic and specific-heat measurements down to 1.8 K are carried out for these systems. $EuCu_3(OH)_6Cl_3$ has a frustrated antiferromagnetic Cu^{2+} ground state with order at 15 K, and a strong anisotropy and increased magnetization from Van Vleck paramagnetic Eu^{3+} contributions. $ZnCu_3(OH)_6(NO_3)_2$ reveals antiferromagnetic order at 9 K and measurements on haydeeite single crystals confirm the ferromagnetic order at 4.2 K with the easy axis within the kagome plane.
[1] P. Puphal et. al., Phys. Rev. Materials 2, 063402

TT 50.11 Wed 15:00 Poster D

Crystal growth and characterization of the frustrated spin systems $Cs_{2-x}Rb_xCuCl_4$ — •Sarah Krebber, Christian Klein, and Cornelius Krellner — Physikalisches Institut, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 1, D-60438 Frankfurt am Main-

Crystals of the antiferromagnetic insulator Cs_2CuCl_4 and the substitution series $(Cs_{2-x}Rb_x)CuCl_4$ (x = 0.1, 0.2) were grown by vertical Bridgman method. The controlled substitution of cesium atoms with the smaller rubidium, causes chemical pressure on the crystal lattice [1]. The essential magnetic units in these systems are Jahn-Teller distorted ($CuCl_4$) tetrahedra, which are arranged in layers separated by the alkali atoms. These layers form a triangular lattice of localized Cu^{2+} spins, where the spins interact through exchange couplings. The resulting geometric frustration leads to quantum spin-liquid properties at low temperatures [2].

In addition to the growth and characterization of $(Cs_{2-x}Rb_x)CuCl_4$, we discuss the structural changes in the lattice parameters and the magnetic behavior of the substituted system in comparison to the well understood parent compound Cs_2CuCl_4.
[1] H. T. Witteveen, D. L. Jongejan and V. Brandwijk, Mater. Res. Bull. 9, 345 (1974)
[2] O. A. Starykh, H. Katsura, and L. Balents, Phys. Rev. B 82, 014421 (2010)

TT 50.12 Wed 15:00 Poster D

Thermal expansion studies on the quantum-spin-liquid candidate $Ca_{10}Cr_7O_{28}$ — •C. Thurn[1], S. Thallapaka[1], U. Tutsch[1], C. Balz[2,3,4], B. Lake[3,4], and M. Lang[1] — [1]PI, Goethe Uni, Frankfurt/M., SFB/TR49, Germany — [2]Oak Ridge National Laboratory, USA — [3]HZ Berlin, Germany — [4]TU Berlin, Germany

In a quantum spin liquid (QSL) strong zero-point fluctuations prevent long-range magnetic order down to lowest temperatures [1]. A common approach for a realization of a QSL is via the help of magnetic frustration of geometric origin. In $Ca_{10}Cr_7O_{28}$ magnetic $S = 1/2$ Cr^{5+}-ions are arranged in distorted kagome bilayers formed by two inequivalent planes of corner-sharing equilateral triangles: an upper triangle coupled ferromagnetically (FM) and a lower triangle coupled antiferromagnetically (AFM) with the FM coupling being dominant. A weak FM inter-plane interaction prevents each plane from reaching its ground state leading to frustration. Previous studies fail to detect any hints of long-range magnetic order down to 19 mK and found persistent spin dynamics down to lowest temperatures [2,3]. Here we present studies of the thermal expansion α and the specific heat C from 1.7 K down to 50 mK for various magnetic fields. For both quantities we find a kink-like anomaly around 0.5 K, indicative of a crossover rather than a phase transition. Measurements of α in low fields reveal a broadening of this feature accompanied by a shift to higher temperatures upon increasing the field, suggesting that FM correlations are at the origin of this feature.
[1] Balents, Nature **464**, 199-208 (2010)
[2] Balz *et al.*, Nat. Phys. **12**, 942-949 (2016)
[3] Balz *et al.*, PRB **95**, 174414 (2017)

TT 50.13 Wed 15:00 Poster D

Anisotropy and spin dynamics in new kagome compound Fe4Si2Sn7O16 — •S. Dengre[1], R. Sarkar[1], J.-C. Orian[2], C. Baines[2], L. Opherden[3], M. Uhlarz[3], T. Herrmannsdörfer[3], T. Söhnel[4], C. D. Ling[5], M. Allision[5], J. Gardner[6], and H.-H. Klauss[1] — [1]Institute of Solid State and Materials Physics, Technical University of Dresden, 01062 Dresden, Germany — [2]Laboratory for Muon-Spin Spectroscopy, Paul Scherrer Institute, 5232 Villigen PSI, Switzerland — [3]Institute of Resource Ecology and Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden-Rossendorf, D-01328 Dresden, Germany — [4]School of Chemical Sciences, University of Auckland, Auckland 1142, New Zealand — [5]School of Chemistry, The University of Sydney, Sydney 2006, Australia — [6]Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organization, Menai 2234, Australia

$Fe_4Si_2Sn_7O_{16}$ is a new Fe-based (S=2) kagome compound and a classical analogue of Herbertsmithite. In this work, we analyse

$Fe_4Si_2Sn_7O_{16}$ using ^{119,117}Sn NMR, bulk AC - DC susceptibility and μSR. NMR reveals the planar anisotropic nature of the system . Moreover, with AC - DC susceptibility, we identify the presence 2 energy scales, i.e. a spin glass-like state at $\sim$ 3 K and a possible spin liquid state below 500 mK. Eventually, μSR results show a persistent spin dynamics down to 20 mK. In conclusion, we describe a compound characterised by the simultaneous presence of static and dynamic spins, which can serve as a model for further theoretical investigations.

TT 50.14 Wed 15:00 Poster D

Effect of silicon substitution in the spin-ice material $Dy_2Ge_{2-x}Si_xO_7$ — •T. Stöter[1,2,3], M. Antlauf[3,4], L. Opherden[1,2], T. Gottschall[2], J. Hornung[1,2], J. Gronemann[1,2], T. Herrmannsdörfer[2], S. Granovsky[1,3,5], M. Schwarz[3,4], M. Doerr[1,3], H.-H. Klauss[1,3], E. Kroke[3,4], and J. Wosnitza[1,2,3] — [1]Institut für Festkörper- und Materialphysik, TU Dresden — [2]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR — [3]SFB 1143 — [4]Institut für Anorganische Chemie, TU Bergakademie Freiberg — [5]Faculty of Physics, M. V. Lomonossov Moscow State University, Russia

The pyrochlores $R_2X_2O_7$ (R = Ho, Dy, X = Sn, Ti, Ge) have attracted interest for their geometrical frustration from which the spin-ice state emerges. The main parameter of the spin-ice physics is the effective nearest-neighbor interaction resulting from the competition of dipolar and exchange interaction. The strength of these competing interactions strongly depends on the interatomic distances. The germanate pyrochlore $Dy_2Ge_2O_7$ possesses one of the smallest known lattice constants ($a = 9.929$ Å), requiring high pressures over 5 GPa for its synthesis. Here we present results of pyrochlores with even smaller lattice parameter by partially substituting silicon for germanium for which pressures of more than 10 GPa are necessary during preparation. We established via magnetization, ac susceptibility and specific-heat measurements that these new compounds are spin-ices with reduced effective interaction,

TT 50.15 Wed 15:00 Poster D

Low-temperature ^{23}Na NMR on the spin liquid candidate $NaYbO_2$ — •D. Dmytriieva[1,2], K. M. Ranjith[3], S. Khim[3], H. Yasuoka[3], J. Wosnitza[1,2], M. Baenitz[3], and H. Kühne[1] — [1]Hochfeld-Magnetlabor Dresden (HLD-EMFL), HZDR, Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany — [3]Max Plank Insitute for Chemical Physics of Solids, Dresden, Germany

The planar $J_{\text{eff}} = 1/2$ triangular-lattice magnet $NaYbO_2$ is a rare-earth chalcogenide with delafossite structure of the $R\bar{3}m$ space group. The antiferromagnetically coupled Yb^{3+} ions form perfect triangular layers, well-separated along the c-axis, designating $NaYbO_2$ as a promising quantum spin-liquid candidate. The combination of strong spin-orbit coupling and crystal electric field results in an effective magnetic moment $J_{\text{eff}} = 1/2$ at low temperatures. We present a study of the low-temperature field-induced phase transition to long-range order, probed by ^{23}Na nuclear magnetic resonance (NMR) spectroscopy and spin-lattice relaxation-rate measurements on a polycrystalline $NaYbO_2$ sample. In contrast to the related spin-liquid candidate $YbMgGaO_4$, exchange disorder is absent, which is further manifested by the narrow electron-spin resonance lines. A sharp maximum of the ^{23}Na spin-lattice relaxation rate, as well as a minimum of the related stretching exponent, indicates the phase transition to long-range order in applied finite fields ($\mu_0 H > 1$ T).

TT 50.16 Wed 15:00 Poster D

High-field ESR studies of the honeycomb-lattice material α-$RuCl_3$ — •A. Ponomaryov[1], E. Schulze[1,2], J. Wosnitza[1,2], P. Lampen-Kelley[3,4], A. Banerjee[5], J.-Q. Yan[4], C.A. Bridges[6], D.G. Mandrus[3], S.E. Nagler[5], and S.A. Zvyagin[1] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany — [3]Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, USA — [4]Department of Materials Science and Engineering, University of Tennessee, Knoxville, USA — [5]Quantum Condensed Matter Division, Oak Ridge National Laboratory, Oak Ridge, USA — [6]Chemical Science Division, Oak Ridge National Laboratory, Oak Ridge, USA

We present results of high-field high-frequency electron spin resonance (ESR) studies of the honeycomb-lattice magnet α-$RuCl_3$ for two principle magnetic-field orientations up to 16 T. For both orientations,$H \parallel [100]$ and $H \parallel [110]$, the polarization dependences are studied. It was found that in contrast to $H \parallel [100]$, the gap at $H \sim 7$ T remains open for $H \parallel [110]$. Peculiarities of the spin dynamics in α-$RuCl_3$ are discussed.

This work was supported by DFG (project ZV 6/2-2 and SFB 1143).

TT 50.17 Wed 15:00 Poster D

Multipolar ordered magnetic ground state of the triangular Ising antiferromagnet $TmMgGaO_4$ — •A. Hauspurg[1,2], L. Opherden[1], S. Chattopadhyay[1], M. Uhlarz[1], T. Herrmannsdörfer[1], and J. Wosnitza[1,2] — [1]Hochfeld-Magnetlabor Dresden (HLD-EMFL), HZDR, Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany

$TmMgGaO_4$ is a quasi-two-dimensional triangular spin system with Ising anisotropy. As a sister compound of $YbMgGaO_4$, which recently was identified as a spin liquid material, it turned out to show a different magnetic ground state at low temperatures. In terms of an almost absent zero-point entropy and distinct anomalies in ac susceptibility a variety of exotic magnetically ordered multipolar phases is observed at very low temperatures. In our work, we present latest results of ac-susceptibility and vector-magnetometry experiments performed on single-crystalline $TmMgGaO_4$ at lowest temperatures and up to high magnetic fields.

TT 50.18 Wed 15:00 Poster D

Exploring the magnetism of the new frustrated $S = 1$ isolated spin-triangle system BHAP-Ni_3 — •S. Chattopadhyay[1], B. Lenz[2], S. Kanungo[3], S. K. Panda[2], S. Biermann[2,5], W. Schnelle[6], K. Manna[6], M. Uhlarz[1], Y. Skourski[1], T. Herrmannsdorfer[1], R. Patra[4], and J. Wosnitza[1,7] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Germany — [2]Centre de Physique Théorique, Ecole Polytechnique, France — [3]School of Physical Sciences, IIT Goa, India — [4]Department of Chemistry and Centre for Advanced Studies in Chemistry, Panjab University, India — [5]Collège de France, Paris, France — [6]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [7]Institut für Festkörper- und Materialphysik, TU Dresden, Germany

We report a combined experimental and theoretical study on the new frustrated quantum-magnet BHAP-Ni_3 synthesized in single-crystalline form. BHAP-Ni_3 provides an ideal opportunity to study the magnetism of a frustrated spin-triangle unit as it is comprised of spin-1 triangles where each triangle is essentially magnetically isolated. Our pulsed-field magnetometry reveals the presence of an exotic state that stabilizes a pronounced 2/3 magnetization plateau between 7 and 20 T. AC-susceptibility measurements performed down to 60 mK show the absence of magnetic order or a glassy state in this material. The magnetic ground state is found to be disordered and specific-heat measurements show a gapped nature of spin excitations. Our theoretical modeling suggests that the 2/3 plateau originates from the interplay between Heisenberg and biquadratic spin-spin interactions.

TT 50.19 Wed 15:00 Poster D

Phase diagram of the natural mineral green dioptase $Cu_6[Si_6O_{18}]\cdot 6H_2O$ — •Erik Schulze[1,2], Alexey N. Ponomaryov[1], Denis I. Gorbunov[1], Toshihiro Nomura[1], Sergei Zherlitsyn[1], Jochen Wosnitza[1,2], Andrey Podlesnyak[3], and Sergei A. Zvyagin[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Dresden, Germany — [3]Quantum Condensed Matter Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA

We present combined high-field ultrasound, magnetization, and electron spin resonance studies of the natural mineral green dioptase ($Cu_6[Si_6O_{18}]\cdot 6H_2O$). This material orders antiferromagnetically below $T_N = 14.5$ K, forming a spiral chain structure with a propagation vector along the c axis. Although a ferromagnetic interaction in the ab plane couples the system into a three-dimensional framework, the material shows clear signatures of large quantum fluctuations, suggesting the low-dimensional nature of the spin correlations. The obtained phase diagram, studied in magnetic fields up to 80 T, reveals several magnetic phases, whose peculiarities are discussed.

This work was supported by Deutsche Forschungsgemeinschaft (project ZV 6/2-2).

TT 50.20 Wed 15:00 Poster D

Magnetic and ultrasound investigation of the frustrated magnet $Nd_2Zr_2O_7$ at low temperatures. — •Y. Gritsenko[1,2,3], M. Ciomaga Hatnean[4], O. A. Petrenko[4], G. Balakrishnan[4],

S. Zherlitsyn[3], and J. Wosnitza[1,2,3] — [1]SFB 1143, Dresden — [2]Institut für Festkörper- und Materialphysik, TU Dresden — [3]Hochfeld-Magnetlabor Dresden (HLD-EMFL), HZDR, Germany — [4]Department of Physics, University of Warwick, Coventry, CV4 7AL, United Kingdom

We report ultrasound and magnetic property studies of large high-quality single crystals of the frustrated magnet $Nd_2Zr_2O_7$, with pyrochlore structure. The temperature dependence of the magnetic susceptibility and the acoustic properties show no magnetic ordering down to 0.5 K. Fits to the magnetic-susceptibility data using a Curie-Weiss law reveal a ferromagnetic coupling between the Nd moments. Magnetization versus field measurements show a local Ising anisotropy along the <111> axes of the Nd^{3+} ions in the ground state. We performed ultrasound measurements for c_{44} acoustic mode (with wave vector parallel to [110], and polarization along [001]), with magnetic field applied along the [110] direction. We observed distinct anomalies below 1 K. A sharp minimum at about 0.25 T suggests a field-induced phase transition.

TT 50.21 Wed 15:00 Poster D

Investigation of the magnetic interactions in the tripod-Kagome compound $Mg_2Gd_3Sb_3O_{14}$ by electron spin resonance experiments — •Christoph Wellm[1,2], Julian Zeisner[1,2], Mihai Sturza[1], Gaël Bastien[1,2], Sebastian Gass[1], Anja U.B. Wolter[1], Bernd Büchner[1,2], and Vladislav Kataev[1] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, D-01171 — [2]Institut für Festkörper-und Materialphysik, TU Dresden, D-01062

As an example of a class of geometrically frustrated magnetic systems, the so-called tripod Kagome materials have been suggested as an interesting target of experimental investigation due to the frustrated nature and the question of dimensionality of the magnetic interactions. In our work we performed high-field electron spin resonance measurements on a powder sample of $Mg_2Gd_3Sb_3O_{14}$, a representative of a quasiclassical Heisenberg magnet, where the effect of spin-orbit coupling of Gd^{3+} ions vanishes to first order. Measurements were conducted over a frequency range of 70-420 GHz and temperatures ranging from 3-50 K. The Gaussian lineshape is consistent with a model of dominant dipolar spin-spin interactions, while the growing asymmetry of the lineshape upon decrease of temperature signifies an increase of an effective internal field, an indication of increasing short-range spin-spin-correlations. Such a behavior is typical for frustrated systems, making our studies one of the first to reveal such significant features in this family of materials. Furthermore, temperature dependent critical broadening of the linewidth and increase of the internal field strength provide insights into the dimensionality of the spin-spin correlations.

TT 50.22 Wed 15:00 Poster D

Unveiling the QSL ground state: An optical study on $Cu_5V_2O_{10}$(CsCl) — •Tobias Biesner[1], Andrej Pustogow[1,2], Hong Zheng[3], John F. Mitchell[3], and Martin Dressel[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]UCLA Physics and Astronomy, USA — [3]Materials Science Division, Argonne National Laboratory, USA

The copper oxide Averievite $Cu_5V_2O_{10}$(CsCl) hosts highly frustrated $S = 1/2$ kagome planes connected in 3D by a honeycomb sublattice. Due to the large intra- and interlayer coupling of the magnetic copper ions, the material possesses an antiferromagnetic ground state ($T_N = 24$ K). By replacing Cu ions within the honeycomb lattice by Zn, the kagome planes decouple and the long-range magnetic order is suppressed, glancing at the celebrated quantum spin liquid.

We present a comprehensive optical study on $Cu_{5-x}Zn_xV_2O_{10}$(CsCl) for various Zn substitutions $x \leq 1.25$ in a broad range of frequencies from the THz region to the visible range and down to $T = 10$ K. Comparing our experimental results with the recent band structure calculations, we elaborate the rich electronic structure and the possible low-energy excitations.

TT 50.23 Wed 15:00 Poster D

The complex magnetic phase diagram of clinoatacamite — •Jannis Willwater[1], Jan Lennart Winter[1], Leonie Heinze[1], Dirk Menzel[1], Stefan Süllow[1], Manfred Reehuis[2], Fabiano Yokaichiya[2], Ralf Feyerherm[2], Harald O. Jeschke[3,4], and Roser Valentí[4] — [1]IPKM, TU Braunschweig, Braunschweig, Germany — [2]HZB, Berlin, Germany — [3]Okayama University, Okayama, Japan — [4]Institut für Theoretische Physik, Goethe-Universität Frankfurt, Frankfurt, Germany

The natural mineral clinoatacamite ($Cu_2Cl(OH)_3$) has been discussed as geometrically frustrated magnet. The Cu^{2+} ions form a system of kagome layers with an antiferromagnetic in-plane coupling. This 2-dimensional geometrical frustration may lead to exotic quantum states at low temperatures.

Here, we present an extensive study using different experimental methods that reveal a complex magnetic phase diagram of the material at low temperatures. The measurements of the specific heat, magnetic susceptibility and magnetization as well as neutron scattering experiments indicate the existence of three phase transitions. Neutron scattering, specific heat and magnetization suggest a canted ferromagnetic order beneath the first transition at 6.4 K. A second transition seen by specific heat is close by in zero field at 6.6 K, but strongly field dependent. By specific heat and susceptibility a third transition at 18.2 K is identified. The nature of the latter two transitions are unknown yet and require further investigations.

TT 50.24 Wed 15:00 Poster D

Ground-state phase diagram of the frustrated spin-$\frac{1}{2}$ two-leg honeycomb ladder — Qiang Luo[1], Shijie Hu[2], Jize Zhao[3], •Alexandros Metavitsiadis[4], Sebastian Eggert[2], and Xiaoqun Wang[5,6] — [1]Department of Physics, Renmin University of China, Beijing 100872, China — [2]Department of Physics and Research Center Optimas, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [3]Center for Interdisciplinary Studies, Lanzhou University, Lanzhou 730000, China — [4]Institute for Theoretical Physics, Technical University Braunschweig, 38106 Braunschweig, Germany — [5]Key Laboratory of Artificial Structures and Quantum Control (Ministry of Education), School of Physics and Astronomy, Tsung-Dao Lee Institute, Shanghai Jiao Tong University, Shanghai 200240, China — [6]Collaborative Innovation Center for Advanced Microstructures, Nanjing 210093, China

We investigate a spin-1/2 two-leg honeycomb ladder with frustrating next-nearest-neighbor (NNN) coupling along the legs, which is equivalent to two J_1-J_2 spin chains coupled with $J_\perp$ at odd rungs. The full parameter region of the model is systematically studied using conventional and infinite density-matrix renormalization group as well as bosonization. We find a rich phase diagram consisting of five distinct phases. In addition, we fully analyze the universalities of the critical phase transitions.

TT 50.25 Wed 15:00 Poster D

Bose condensation of squeezed light — •Klaus Morawetz — Münster University of Applied Sciences,Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics-UFRN,Campus Universitário Lagoa nova,59078-970 Natal, Brazil

Light with an effective chemical potential and no mass is shown to possess a general phase-transition curve to Bose-Einstein condensation. This limiting density and temperature range is found by the diverging in-medium potential range of effective interaction. While usually the absorption and emission with Dye molecules is considered, here it is proposed that squeezing can create also such an effective chemical potential. The equivalence of squeezed light with a complex Bogoliubov transformation of interacting Bose system with finite lifetime is established with the help of which an effective gap is deduced. This gap phase creates a finite condensate in agreement with the general limiting density and temperature range. The phase diagram for condensation is presented due to squeezing and the appearance of two gaps is discussed.
[1] arXiv:1809.09525

TT 50.26 Wed 15:00 Poster D

Laser Control of Topological Polaritons — •Damian Hofmann and Michael Sentef — Max Planck Institute for the Structure and Dynamics of Matter, Luruper Chaussee 149, 22761 Hamburg, Germany

Polaritons are quasiparticles consisting of a superposition of photons and excitons. We study a semiconductor microcavity system in which multiple semiconductor layers are coupled to a single photonic mode. A momentum-dependent complex phase in the exciton-photon coupling gives rise to non-trivial topological properties of the polariton bands. In particular, the system possesses chiral edge modes which can be excited by optical pumping near the sample boundary.

We simulate the dynamics of the driven system in the semi-classical approximation using a Gross-Pitaevskii-type equation. This allows us to study topologically protected chiral transport along the edges of a finite sample. We further discuss the dynamics of a lattice version of the topological polariton model, from which we obtain time-resolved

spectral information and demonstrate the selective excitation of the | edge modes.