WEDNESDAY, May 22

	Arrival	
12:30–14:00	**Lunch**	
14:00–14:30	**Welcome/Opening Remarks**	Matthias Bode JMU Würzburg
14:30–15:30	**Session 1 – Quantum Monte Carlo Simulations** *Chair: Sushmita Chandra*	
14:30–14:50	Spin-Peierls Kitaev-Heisenberg modes: auxiliary field quantum Monte Carlo studies	João Carvalho Inácio JMU Würzburg
14:50–15:10	Visualization of hydrodynamic electron-flow with quantum Monte Carlo	Adrien Reingruber JMU Würzburg
15:10–15:30	Higgs Phases and Boundary Criticality	Kristian Chung MPI-PKS Dresden
15:30–15:50	Overview of ct.qmat Collaborative Research Data Infrastructure	Jonas Schwab JMU Würzburg
15:50–16:00	**Group Photo**	
16:00–16:30	**Coffee Break & Check-In**	
16:30 –17:30	Ice Breaker	
17:30–19:00	**Poster Session 1**	
19:00–20:30	**Dinner**	
20:30	**Fireplace Chat**	

THURSDAY, May 23

08:00–09:00	**Breakfast**	
09:00–10:30	Microwave transport in topological edge states *Chair: Tobias Helbig*	Erwann Bocquillon University of Cologne
10:30–11:00	**Coffee Break**	
11:00–12:20	**Session 2 – Physical Properties of Quantum Materials** *Chair: Holger Diehm*	
11:00–11:20	Towards a more fundamental understanding of eigenstate thermalization	Tobias Hofmann JMU Würzburg
11:20–11:40	Nanofabrication of Misfit Crystals	Sushmita Chandra MPI-CPfS Dresden
11:40–12:00	Kondo screening in Kitaev spin liquids with a Fermi surface	Michel Miranda TU Dresden
12:00–12:20	Orbital-Selective Spin-Triplet Superconductivity in Infinite-Layer Lanthanum Nickelates	Fabian Jakubczyk TU Dresden
12:20–14:00	**Lunch**	
14:00–14:30	**QMA representatives session**	
14:30–16:00	**Poster Session 2**	
16:00–16:30	**Coffee Break**	
16:30–19:00	**City Tour**	
19:00–20:30	**Dinner**	
20:30	**Pub Crawl**	

FRIDAY, May 24

08:00–09:00	**Breakfast**	
09:00–09:30	Workshop – Daring to Face the Unknown: Diversity, Dignity, and Hidden Bias Part III	Inna Zeitler Wissen Haltung Wandel
09:30–10:30	**Session 3 – Weyl Semimetals and Quantum Phase Transition** *Chair: Tobias Helbig*	
09:30–09:50	Stability of Weyl node merging processes under symmetry constraints	Gabriele Naselli IFW Dresden
09:50–10:10	Surface superconductivity on time-reversal symmetric Weyl systems: a self-consistent approach	Mattia Trama IFW Dresden
10:10–10:30	New mechanism for continuous order-to-order quantum phase transitions	David Moser IFW Dresden
10:30–11:00	**Coffee Break & Check-Out**	
11:00–12:30	Classical and quantum liquids in magnetism *Chair: Daniel Lozano-Goméz*	Johannes Reuther Freie Universität Berlin
12:30–14:00	**Lunch**	
14:00–15:00	**Closing Remarks & Best Poster Awards**	
15:00	**Departure**	

Poster-Contributions

No	Title	Presenter
1	Truncated Hilbert space approach for simulating dynamics in perturbed quantum Ising chains	Nico Albert TU Dresden
2	Properties of a MoS_2 monolayer	Andreas Christ JMU Würzburg
3	Electronic and magnetic properties of Cr_2Se_3 thin films studied by spectroscopies.	Chien Wen Chuang JMU Würzburg
4	Growth and spectroscopy of altermagnetic MnTe	Marco Dittmar JMU Würzburg
5	Art of Kagome	Stefan Enzner JMU Würzburg
6	Spin vestigial orders and ferrimagnetism in $Na_2Co_2TeO_6$	Niccolò Francini TU Dresden
7	Superconducting tunnel junctions in topological superconductor candidate half-Heusler YPtBi.	Vatsal Jain JMU Würzburg
8	Topological states supported by the bulk in the quasicrystalline Bernevig-Hughes-Zhang model	Mani Chandra Jha MPI-PKS Dresden
9	Kondo screening in Kitaev-type spin-orbitals liquids	Christos Kourris TU Dresden
10	Probing Spin-Dependent Ballistic Charge Transport at Single-Nanometer Length Scales	Markus Leisegang JMU Würzburg
11	Candidate Quantum Spin Liquids in Spin-1 Diamond Lattice : Generalization of Projective Symmetry Group Approach	Atanu Maity JMU Würzburg
12	Manipulating topology of quantum phase transitions by flavor enhancement	Gabriel Rein JMU Würzburg
13	Exceptional points at X-ray wavelengths	Fabian Richter JMU Würzburg
14	Anomalous electronic properties of $ZrTe_5$	Shailja Sharma IFW Dresden
15	Quantum optics model mapping for thin-film x-ray cavities	Julien Spitzlay JMU Würzburg
16	Electronic reconstruction and anomalous Hall effect in the LAO/SRO heterostructure	Merit Spring JMU Würzburg
17	Topological state manipulation in 1-3D photonic systems	Min Tang IFW Dresden
18	Tuning the magnetic properties of V-doped $(Bi,Sb)_2Te_3$ topological insulator	Abdul-Vakhab Tcakaev JMU Würzburg

Abstracts Talks

Spin-Peierls Kitaev-Heisenberg modes: auxiliary field quantum Monte Carlo studies

João Carvalho Inácio
JMU Würzburg

Recently we have formulated auxiliary field quantum Monte Carlo simulations Heisenberg-Kitaev model [1]. This approach offers the possibility of reaching temperature scales roughly a factor two smaller that the magnetic scale before running into severe negative sign problems. Here we show that we can generalize this approach to include Einstein phonons. Importantly we show that the inclusion of phonons does not render the sign problem more severe such that the approach offers the possibility of investigating signatures of fractionalisation on phonon spectral functions.

[1] T. Sato and F. F. Assaad, Phys. Rev. B **104** (2022)

Visualization of hydrodynamic electron-flow with quantum Monte Carlo

Adrien Reingruber
JMU Würzburg

The realization of ultra-clean graphene samples with predominant electron-electron scattering, opened the possibilities to study electron transport in hydrodynamic regime, where the electronic transport properties are characterized by viscous Poiseuille flow or the breakdown of Wiedemann-Franz law. Only recently these effects were measured experimentally. We start from a microscopic tight-binding Hamiltonian with long-range Coulomb interactions and visualize hydrodynamic flow of electrons in finite-sized charge-neutral graphene sheets using non perturbative Quantum Monte Carlo (QMC) calculations. We show the necessity to supplement the conventional Navier-Stokes equation with additional dissipation terms stemming from Umklapp-processes and disorder from adatoms at the edges to adequately describe the hydrodynamic flow of electrons in the studied graphene samples. It leads to some modifications of the well-known Poiseuille profiles. Using this phenomenological description, the viscosity is extracted from our QMC data and compared to previous analytical and experimental results.

Higgs Phases and Boundary Criticality

Kristian Chung
MPI-PKS Dresden

Higgs phases appear in theories of a charged boson interacting with a dynamical gauge field. The prototypical example from condensed matter physics is a superconductor: when charged cooper pairs condense, they generate a mass for photons, resulting in the Meissner effect. Based on my recent work [1], I will discuss the relationship between Higgs phases and boundary symmetry breaking. The core observation motivating this work is that the notion of "charge condensate" is ambiguous, because the conservation of charge symmetry is not physical in a gauge theory, unless one introduced boundary conditions allowing flux to leave the system. The symmetry is then physically realized on the boundary and can spontaneously break. I discuss this in both abelian and non-Abelian models, and comment on connections between Higgs and Symmetry Protected Topological (SPT) phases.

[1] arXiv:2404.17001

Overview of ct.qmat Collaborative Research Data Infrastructure

Jonas Schwab
JMU Würzburg

I will give an overview of the cluster's Collaborative Research Data Infrastructure and demonstrate how to use the services.

Microwave transport in topological edge states

Erwann Bocquillon
University of Cologne

High-frequency measurements in the DC-10 GHz range constitute a powerful toolbox to explore the dynamics of quantum conductors such as topological edge states. For example, they yield information on the role of Coulomb interaction on the edge states dynamics, and allow for controlling edge excitations down to the single electron scale. In this lecture, we will present the main concepts and some examples of applications of microwave transport.

Towards a more fundamental understanding of eigenstate thermalization

Tobias Hofmann
JMU Würzburg

The eigenstate thermalization hypothesis (ETH) connects the field of statistical physics with quantum mechanics. It suggests that an eigenstate of a quantum many-body system acts as a (micro)canonical ensemble for small local subsystems. While the ETH was applied to and tested in a variety of physical systems, its microscopic origin is still not completely known. In this presentation, we discuss how it can be understood more fundamentally by employing concepts from random matrix theory. In particular, we report on random matrix computations for a spin system with random couplings and compare the results to our numerical findings.

Nanofabrication of Misfit Crystals

Sushmita Chandra
MPI-CPfS Dresden

Recently, MISFIT layered compounds (MLCs) have attracted considerable attention in the field of 2D materials due to their unique structure, crystallographic diversity, and chemical tunability. Typically, MLCs can be represented by the general formula [(MX)(1+δ)]m[(TX2)n] with m, n = 1, 2, 3, where M = Sn, Sb, Pb, Bi, rare-earth elements; T = Ta, Nb, Mo, etc., and X= S, Se, Te.[1, 2] The lattice mismatch between the distorted rock salt MX layers and hexagonal TX2 counterparts creates a strained interface in the MLCs which allows a charge transfer from one layer to another, leading to a wealth of fascinating physical phenomena and modulations in the electronic structure.[3] Although MLCs have been extensively studied for their potential applications in thermoelectrics, the fabrication of nanodevices with single- or multilayer MISFIT crystals is a challenging task and has not been explored at all. In this talk, I will present the fabrication of nanodevices based on high quality MISFIT single crystals. I will also correlate how the misfit strain is associated with the superconducting transition and affects the electronic transport in these natural van der Waals heterostructures.

[1] Radovsky, G., Popovitz-Biro, R., Stroppa, D. G., Houben, L. & Tenne, R. Acc. Chem. Res. **47**, 406–416 (2014)
[2] Sreedhara, M. B. et al., Proc. Natl. Acad. Sci. **118**, e2109945118 (2021)
[3] Ng, N. & McQueen, T. M., APL Mater. **10**, 100901 (2022)

Kondo screening in Kitaev spin liquids with a Fermi surface

Michel Miranda
TU Dresden

Isolated magnetic impurities can be used to probe the low-energy properties of a host system, with the standard Kondo effect in metals being the paradigmatic example. Magnetic impurities have also been discussed as probes of quantum spin liquids and their excitations, and various approximate theoretical treatments have been put forward. In particular, it has been suggested that a spin liquid with a spinon Fermi surface would lead to Kondo screening akin to that in normal metals. Here we study this problem for a particular Kitaev model with a Majorana Fermi surface, realized on the square-octagon lattice. We present a numerically exact solution using Wilson's Numerical Renormalization Group (NRG) which generalizes previous work for the honeycomb-lattice Kitaev model. Our numerical data for the renormalization-group flow and for thermodynamic observables highlight important differences between the Kitaev system and a metal, related to the fractionalization scheme and the influence of the emergent gauge field.

Orbital-Selective Spin-Triplet Superconductivity in Infinite-Layer Lanthanum Nickelates

Fabian Jakubczyk
TU Dresden

The discovery of superconductivity in infinite-layer nickelates has ignited stark interest within the scientific community, particularly regarding its likely unconventional origin. Conflicting agnetotransport measurements report either isotropic or anisotropic suppression of superconductivity in an external magnetic field, with distinct implications for the nature of superconducting order. In order to ensure a most suited model subject to subsequent many-body analysis, we develop a firstprinciples-guided minimal theory including Ni $dx_2{-}y_2$, La d_{3z2-r2}, and La d_{xy} orbitals. Amended by the consideration of orbital-selective pairing formation, which emphasises the correlation state of the Ni $3d_{x2-y2}$ orbital, we calculate the superconducting ordering susceptibility mediated by spin fluctuations. We find a parametric competition between even-parity d-wave and, in contrast to previous studies, odd-parity p-wave pairing, which becomes favorable through a large quasiparticle weight renormalization for Ni $3dx_2{-}y_2$ electrons. Our findings not only shed light on the distinctiveness of $LaNiO_2$ as compared to cuprate superconductors or nickelates of different rare-earth composition but also suggest similarities to other candidate odd-parity superconductors.

Daring to Face the Unknown: Diversity, Dignity, and Hidden Bias Part III

Inna Zeitler
Wissen Haltung Wandel

TBA

Stability of Weyl node merging processes under symmetry constraints

Gabriele Naselli
IFW Dresden

Changes in the number of Weyl nodes in Weyl semimetals occur through merging processes, usually involving a pair of oppositely charged nodes.More complicated processes involving multiple Weyl nodes are also possible, but they typically require fine tuning and are thus less stable.In this work, we study how symmetries affect the allowed merging processes and their stability, focusing on the combination of a two-fold rotation and time-reversal C_2T symmetry. We find that, counter-intuitively, processes involving a merging of three nodes are more generic than processes involving only two nodes.Our work suggests that multi-Weyl-merging may be observed in a large variety of quantum materials, and we discuss $SrSi_2$ and bilayer graphene as potential candidates.

Surface superconductivity on time-reversal symmetric Weyl systems: a self-consistent approach

Mattia Trama
IFW Dresden

The recent discovery of the superconducting surface on the timereversal symmetric Weyl semimetal $PtBi_2$ has raised the question of the origin of such a phenomenon. Indeed, such a compound exhibits a critical temperature difference between the surface and the bulk of about an order of magnitude. Here we propose an explanation for this phenomenon using a time-reversal symmetric Weyl model for a finite system, invoking standard local s-wave singlet pairing as the superconducting coupling. Our self-consistent calculation predicts a different critical temperature for the surface and the bulk, leading to the possibility of superconductivity in only few layers of the material. We also predict a temperature dependence on the penetration of surface superconductivity, suggesting a competition between two order parameters.

New mechanism for continuous order-to-order quantum phase transitions

David Moser
IFW Dresden

The Landau-Ginzburg-Wilson paradigm has lead to tremendous understanding of a great number of phase transition phenomena over the last 50 years. During the last three decades, however, the paradigm has been challenged various times. One such instance was the discovery of deconfined quantum phase transitions, hence (potentially) continuous order-to-order quantum phase transitions enabled by fractionalization. Here, we propose a different mechanism generating (unambiguously) continuous order-to-order quantum phase transitions. The proposed mechanism is based on a fixed point annihilation and does not rely on fractionalization. We exemplify this mechanism in a non-relativistic, 3 + 1-dimensional theory of quadratic band touching fermions and in quantum electrodynamics in 2 + 1 spacetime dimensions. A brief introduction to the renormalization group is given.

Classical and quantum liquids in magnetism

Johannes Reuther
Freie Universität Berlin

Many-body systems with liquid-like properties follow a widespread construction principle: Elementary constituents have classical or quantum dynamics that allows them to explore their configuration space. On the other hand, the dynamics are restricted by local constraints. The interplay of the two opposing effects can produce a wealth of fascinating liquid-like phenomena. In this talk I will discuss various examples of this principle in the field of magnetism, including classical and quantum systems. A particular focus lies on establishing the connection between magnetic liquids and emergent gauge theories. Presented examples include quantum dimer models, spin ice systems, fractonic models and spiral liquids.

Truncated Hilbert space approach for simulating dynamics in perturbed quantum Ising chains

Nico Albert
TU Dresden

Simulating dynamics in interacting quantum many-body systems is a challenging problem. We develop a truncated Hilbert space approach (THSA) and apply it to the quantum Ising chain with both transverse and longitudinal fields for studying its spectrum and quench dynamics. We find that the characteristic features of this model, such as E_8 particles with universal mass ratios, are well captured in the truncated Hilbert space approach. We also use this new method to study the confinement dynamics of domain-wall bound states in the ferromagnetic phase.

Properties of a MoS_2 monolayer

Andreas Christ
JMU Würzburg

Since the first discovery of graphene, two-dimensional materials have received significant interest in the scientific community. In this context, layered van-der-Waals materials such as transition metal dichalcogenides (TMDs), which even in a bulk crystal exhibit a quasi-2D like electronic structure due to their very weak interlayer interaction, stand out particularly. TMDs exhibit a unique combination of atomic-scale thickness, direct bandgap, strong spin–orbit coupling and favourable electronic and mechanical properties [1], which make them interesting for fundamental studies and for applications in high-end electronics, spintronics, optoelectronics, and energy harvesting. TMD monolayers are particularly fascinating, as their perfect 2D character results in extraordinary properties. For example, the band gap of molybdenum disulfide (MoS2) changes from indirect for bulk material to direct for the monolayer [2]. However, a free-standing monolayer is illusive and so the interaction between an underlying substrate and the sample needs to be considered. In our studies, we will focus on the interaction of a MoS2 monolayer with a Au substrate. Moreover, we plan to investigate novel properties of monolayer flakes like edge states by STM [3].

[1] K. Lasek et al.; Surf. Sci. Rep. **76**, 100523 (2021)
[2] K. F. Mak et al.; Phys. Rev. Lett. **105**, 136805 (2010)
[3] M. V. Bollinger et al.; Phys. Rev. Lett. **87**, 196803 (2001)

Electronic and magnetic properties of Cr2Se3 thin films studied by spectroscopies

Chien Wen Chuang
JMU Würzburg

Two-dimensional (2D) ferromagnets have recently attracted much attention because long-range ferromagnetic (FM) order can be controlled by layer thickness, carrier-doping, and strain. Moreover, they have a high potential for developing next-generation spintronic devices. In this work, we have successfully fabricated monolayer (ML), 2ML and 3ML Cr_2Se_3 on bilayer graphene/6H-SiC (0001) by the molecular-beam epitaxy (MBE) method. The electronic structure related to the FM order of 2D Cr_2Se_3 was carried out by Cr L-edge x-ray magnetic circular dichroism (XMCD) and high-resolution micro-ARPES measurement. The observation of the Cr-L edge XMCD signal confirms that ML Cr_2Se_3 is indeed a 2D ferromagnet, consistent with charge transfer model calculations. APRES results showed systematic evidence for the temperature-dependent band shifts and splitting of localized Cr 3d up spin-t_{2g} bands with increased occupancy of the itinerant Cr 3d up spin-eg band. The t_{2g}-eg spin-valley coupling at the K/K' points of the hexagonal Brillouin zone leads to ferromagnetic ordering, which is confirmed by XMCD. Comparison with 2ML and 3 ML Cr_2Se_3 showed that the valley carrier density plays an important role in enhancing TC for thinner layer films via RKKY interactions and paving the way to realize 2D ferromagnetism at higher temperatures.

Growth and spectroscopy of altermagnetic MnTe

Marco Dittmar
JMU Würzburg

Next to ferromagnetism and antiferromagnetism, a new type of magnetic order, called altermagnetism, has been proposed recently and since attracted great attention. It is characterized by antiferromagnetic spin alignment combined with rotational lattice symmetry, which is reflected in a spin-split band structure with spin polarized electronic states. One of the "workhorse" materials potentially exhibiting this type of magnetic order is MnTe in its hexagonal NiAs-type crystal structure. Here, we investigate MnTe thin films grown on different substrates by molecular beam epitaxy. Using structural characterization methods, we discuss the influence of the growth parameters on the observed films. The electronic structure is assessed by soft X-ray angle-resolved photoemission spectroscopy and shows good agreement with band structure calculations.

Art of Kagome

Stefan Enzner
JMU Würzburg

In physics, the Kagome lattice represents a geometric arrangement of interconnected triangles, often found in materials exhibiting exotic quantum behaviors like spin liquids and topological phases. This lattice structure, characterized by its repeating hexagonal pattern, has garnered significant attention for its potential applications in electronic and magnetic systems. Parallel to its scientific significance, Kagome also holds artistic allure, serving as a timeless motif in Japanese culture and beyond. Artists draw inspiration from its intricate geometry, incorporating it into diverse mediums to evoke themes of symmetry, interconnectedness, and the balance between tradition and innovation. Through an interdisciplinary lens, this poster explores the dual role of Kagome as both a fundamental structure in physics and a source of aesthetic fascination in the realm of art.

Spin vestigial orders and ferrimagnetism in Na2Co2TeO6

Niccolò Francini
TU Dresden

TBA

Superconducting tunnel junctions in topological superconductor candidate half-Heusler YPtBi.

Vatsal Jain
JMU Würzburg

Harnessing the non-Abelian nature of emergent Majorana modes in topological superconductors presents a promising avenue for fault-tolerant quantum information processing, due to the protection offered by the underlying topology. Unfortunately intrinsic topological superconductors are very rare in nature with no conclusive experimental evidence of their existence. Half-Heusler compounds are a promising candidate due to the absence of an inversion center in the crystal lattice. This leads to a Rashba-type antisymmetric spin-orbit coupling (SOC) lifting the spin degeneracy of electronic bands. The SOC can create band inversion imparting non-trivial topology to the band structure and the non-centrosymmetry means that we have mixed parity superconductivity (singlet and triplet). This can be the perfect ingredient for topological superconductivity to emerge. With this idea in mind, we are examining YPtBi, a half-Heusler compound, which showcases strong spin-orbit coupling, p-type bands near the Fermi level and near vanishing density of states. Calculations on the basis of the BCS theory indicate that much larger values of charge carrier density are necessary to account for the value of Tc in the framework of electron-phonon coupling. Due to the band inversion and the four fold degeneracy of the bands near the Fermi level, it was suggested that the Cooper pairs may form between fermions with j = 3/2, instead of the commonly considered j = ½, imparting finite momentum to them. To explore these phenomena, tunnel junctions (S-I-N and S-c-S) were fabricated on YPtBi thin films grown via Molecular Beam Epitaxy. Tunneling characteristics were analyzed to determine the superconducting gap, revealing intriguing features in critical current dependence on magnetic fields. Ongoing efforts focus on refining lithographic processes and enhancing material quality to provide conclusive evidence regarding unconventional pairing and the emergence of topological superconductivity in YPtBi.

Topological states supported by the bulk in the quasicrystalline Bernevig-Hughes-Zhang model

Mani Chandra Jha
MPI-PKS Dresden

The recent discovery of in-gap single-particle topological states of matter in quasicrystalline geometries supported by the bulk of the system instead of the edge marks a striking difference from the properties of crystalline periodic matter. Topological edge states are well-described by band theory and the bulk-boundary correspondence, and the physical motivations of these, combined with the presence of long-range order, mean that the edge states are to be expected in quasicrystalline systems. However, recent results in Hofstadter-type models on quasicrystals have introduced a richer structure in which localised in-gap states with a nonzero topological index can also be supported within the bulk of the system, and survive even in the infinite size limit. Here, we extend these quasicrystalline topological states, named bulk localised transport states, to the quantum spin Hall regime. We study the seminal Bernevig-Hughes-Zhang model restricted to a quasicrystalline geometry, in the form of a graph given by the vertex model of the Ammann-Beenker tiling. We first show that bulk localized transport states exist in each layer of the model when the layers are uncoupled. We then use the spin Bott index to show that the states persist even when the layers are weakly coupled. This provides the first example of bulk localised transport states outside of the single-particle Hofstadter model.

Kondo screening in Kitaev-type spin-orbitals liquids

Christos Kourris
TU Dresden

In systems of itinerant fermions interacting with local moments, the competition between Kondo screening and various types of symmetry breaking and topological order can give rise to rich phenomenology. The existence and type of screening depend crucially on the low-energy properties of the host system. Here we use suitable mean-field schemes to study situations where a single Kondo impurity is coupled to a Kitaev-type spin-orbital liquid, whose excitations are itinerant Majorana fermions.

Probing Spin-Dependent Ballistic Charge Transport at Single-Nanometer Length Scales

Markus Leisegang
JMU Würzburg

Transport measurements that are sensitive to the band structure of a material require techniques that operate on the length scale of the charge carrier's mean free path. In order to get real space access to charge carrier transport at distances of the mean free path and thus in the ballistic regime, we developed and established the molecular nanoprobe (MONA) technique [1,2].Hereby, we use a single molecule as a detector for charge carriers, which are injected into the substrate under investigation by the STM tip a few nanometers away from the molecule. The high spatial resolution of MONA combined with the small size of the molecular detector allows for transport paths which can be controlled at the atomic level. In a very recent experiment, we merged the MONA technique with spin-polarized STM to SP-MONA. By using the Rashba-split surface state of the BiAg2 surface as a test sample, we proof that this technique allows to detect spin-polarized transport at the atomic limit [3].

[1] J. Kügel et al., Nano Lett. **17**, 5106 (2017)
[2] M. Leisegang et al., Nano Lett. **18**, 2165–2171 (2018)
[3] P. Härtl et al., Nano Lett. **23**, 11608 (2023)

Candidate Quantum Spin Liquids in Spin-1 Diamond Lattice: Generalization of Projective Symmetry Group Approach

Atanu Maity
JMU Würzburg

In geometrically frustrated spin systems, novel phases such as quantum spin liquids (QSL) appear due to the quantum mechanical melting of long-range orders. The low dimensional spin S = 1/2 systems are the breeding grounds for such phases due to strong quantum fluctuations. However, some recent findings [1, 2, 3, 4] show the existence of QSLs in three-dimensional spin S = 1 systems. One of the powerful known approaches for S = ½ systems, is Abrikosov fermion mean field theory (AF-MFT) where one can classify all possible mean field Ansätze owing to lattice space group and time reversal symmetries using projective symmetry group (PSG) [5]. Utilizing spin-S AF-MFT [6], we generalized the PSG approach and implemented it on S = 1 Diamond lattice and made a systematic comparison with S = ½ case [7]. The fundamental difference arises from their internal symmetry groups U(1)⨂Z2 and SU(2) for S = 1 and S = ½ respectively. Due to the even parity of the hopping term, the hopping-only Ansätze remains the same for both cases. We find seven such cases in the Diamond lattice when restricted up to the second nearest neighbour. Among these, five appear with invariant gauge group (IGG) U(1) while the other two appear with IGG SU(2) in S = ½ and U(1)⨂Z_2 in S = 1. But due to the odd parity of the pairing term, the Z_2 Ansätze are not same for the two cases. There are a total of eight Z_2 Ansätze in S = ½ system while the number is only one in S = 1 case. Also, in S = 1 case there is an additional IGG Z_2⨂Z_2 where we find two more Ansätze. Furthermore, we carried out a mean-field theoretical analysis with $J_1 - J_2$ Heisenberg model [4] and study the phase diagram and the dispersion spectrum. Interestingly, we obtain a nontrivial multi-nodal-loop band structure in one SU(2) and one U(1) Ansätze. These nodal loops are robust and protected by projective symmetries.

[1] Plumb K.W., Changlani H. J., and Scheie A. et al., Nature Physics **15**, 54-59 (2019).
[2] J. R. Chamorro, L. Ge and J. Flynn et al., Phys. Rev. Materials **2**, 034404 (2018).
[3] Ivica Zivković, Virgile Favre, and C. S. Mejia et al., Phys. Rev. Lett. **127**, 157204 (2021).
[4] F. L. Buessen, M. Hering, J. Reuther, and S. Trebst, Phys. Rev. Lett. **120**, 057201 (2018).
[5] Xiao-Gang Wen, Phys. Rev. B **65**, 165113 (2002).
[6] Zheng-Xin Liu, Yi Zhou, and Tai-Kai Ng, Phys. Rev. B **82**, 144422 (2010).

Manipulating topology of quantum phase transitions by flavor enhancement

Gabriel Rein
JMU Würzburg

We consider a dynamically generated quantum spin Hall (QSH) state, characterized by skyrmion excitations of the SO(3) order parameter carrying charge $2ee$. A model described in [1] uses parameter $\lambda\lambda$ to drive a continuous transition, akin to deconfined quantum criticality, from a QSH insulator to an s-wave superconductor (SSC) via the condensation of charge $2ee$ skyrmions. Here we enhance the symmetry of the model by introducing an additional flavor index $NNNN$ = 2. Remarkably, we observe a new Kékulé (VBS) phase and transitions between QSH/SSC as well as VBS/SSC. All phase transitions turn out to be of Ginzburg-Landau type. For the VBS/SSC transition we argue that this is due to a $\theta\theta$-term at $\theta\theta$ = $NNNN$ $\pi\pi$.For the QSH/SSC transition, we conjecture that in 2+1 d the non-linear sigma model with level $NNNN$ Wess-Zumino-Witten term has relevant operators that induce ordered phases, thus requiring fine-tuning for observing a continuous transition. Similarities to the 1+1 d case [2] are highlighted.

[2] Y. Liu et al., Nat. Comm.**10**, 2658 (2019)
[1] I. Affleck et al., Phys. Rev. B **36**, 5291 (1987)

Exceptional points at X-ray wavelengths

Fabian Richter
JMU Würzburg

Non-Hermitian Hamiltonians allow for an effective description of dissipative systems. They exhibit a variety of exciting phenomena that cannot be observed in the Hermitian realm. Exceptional Points (EPs) are a prime example of this. At EPs not only the complex eigenvalues, but also the eigenvectors coalesce and sensitivity to perturbations is drastically enhanced. This concept has recently found fertile ground in optics and photonics where non-Hermitian eigenstates can be created and superposed through optical gain and loss. So far, these concepts have been mostly discussed in the optical regime. Similar control of x-rays is desirable due to their superior penetration power, high focus ability and detection efficiency. Here, we investigate theoretically non-Hermitian x-ray photonics in a thin-film cavity setup containing Mössbauer nuclei resonant to the x-ray radiation entering under grazing incidence. These cavities present loss that can be controlled via adjustment of the cavity geometry and the incidence angle of the x-rays. Application of a magnetic hyper- fine field paves the way to tune the system towards EPs and to explore their rich topological properties.

Anomalous electronic properties of $ZrTe_5$

Shailja Sharma
IFW Dresden

$ZrTe_5$ is known for its large thermopower and resistivity anomaly and offers a promising platform to study topological phase transition. Recent years have witnessed non-trivial and complex electronic properties that assigned this material to either a strong topological insulator or a 3D Dirac semimetal phase. Here, I will present magnetoresistance results on $ZrTe_5$ depicting different resistivity anomaly temperature T* in distinct crystals. Strong temperature dependence of band-structure has also been observed in p- to n-type transition across the resistivity anomaly in Hall and Seebeck coefficient measurements.

Quantum optics model mapping for thin-film x-ray cavities

Julien Spitzlay
JMU Würzburg

Thin-film cavities with one or several embedded layers of Mössbauer nuclei are promising platforms for the quantum control of x-ray photons. At grazing incidence, incoming resonant x-rays couple evanescently to the cavity, while the resulting cavity field drives the nuclear transitions. Several quantum optics models have been developed in the past decade to describe the resonant x-ray scattering in these nanostructures, for instance a cavity QED model or an ab-initio formalism based on the electromagnetic Green's function. In this work we investigate parallels between the x-ray thin-film cavity models and well-known quantum optics models for coherent phenomena in few-level systems such as electromagnetically induced transparency (EIT) or Autler-Townes-Splitting (ATS). The aim is to identify parameter regimes where thin-film x-ray cavities can display a behaviour reminiscent to these phenomena and the relations between the coupling constants of the respective underlying quantum optics models.

Electronic reconstruction and anomalous Hall effect in the LAO/SRO heterostructure

Merit Spring
JMU Würzburg

4d and 5d transition metal oxides are a promising class of materials for topological phases in the context of electron correlations. Recently, the ferromagnetic metal $SrRuO_3$ (SRO) grown on a $SrTiO_3$ (STO) (001) substrate has been reported to exhibit electronic-reconstruction induced interfacial charge pinning accompanied by a topological transition of its electronic bands when capped with a $LaAlO_3$ (LAO) layer [1]. LAO is a polar oxide and the electronic reconstruction in a heterosystem of LAO/STO caused by the polar discontinuity at the interface is well known. For the LAO/SRO system a similar behavior is expected and charge is thought to be accumulated at the very interface giving rise to strong inversion-symmetry breaking and hence change in the momentum-space topology [1]. Here we show the observation of signatures of an anomalous Hall effect in 4uc SRO films capped with LAO but also with non-polar STO. We correlate these findings with angle-dependent XPS data that allow for depth-profiling the oxidation state of ruthenium in both systems.

[1] Thiel, T. C. et al., Phys. Rev. Lett. **127**, 127202 (2021)

Topological state manipulation in 1-3D photonic systems

Min Tang
IFW Dresden

The generation and manipulation of topological states in 1-3D photonic systems show intriguing properties and unique applications. For the 1D system, we explore the selective excitation of topological trivial/nontrivial states by tuning the symmetry and/or dynamic phase of the topological zero mode. For the 2D system, ultralow-threshold polariton condensation at BICs in organic semiconductor photonic crystals is investigated. For the 3D systems, the berry phase acquired in the Möbius ring and microtubular resonators are studied. In addition, non-Hermitian photonics is studied by introducing perovskite materials as the gain medium. These studies are of high interest for both fundamental research and practical applications such as quantum computing and optical communications.

Tuning the magnetic properties of V-doped $(Bi,Sb)_2Te_3$ topological insulator

Abdul-Vakhab Tcakaev
JMU Würzburg

TBA