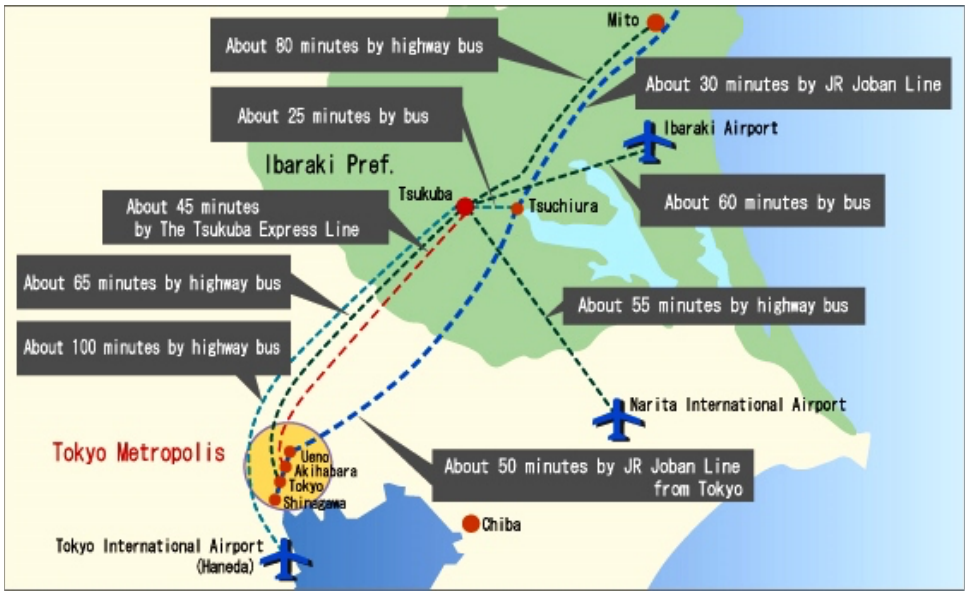
Trends in Theory of Correlated Materials (TTCM2017)

Sep. 10-13 (2017)

Tsukuba International Congress Center (EPOCHAL TSUKUBA)



Schedule

Sep.10, 18:00 : Welcome party

Sep.11,

8:40-9:00 : Registration

9:00-17:40 : Scientific session

Sep.12

9:00-17:30 : Scientific session

18:00- : Banquet

Sep.13

8:30-12:25 : Scientific session

12:30- : Excursion

Supports

[1] Japan Society for the Promotion of Science (JSPS): "Bilateral Joint Research Seminar FY2017"

[2] INOUE foundation for promotion of science

International Congress Center
EPOCHAL TSUKUBA

Scope

This workshop "Trends in Theory of Correlated Materials (TTCM2017)" is a continuation of very successful bilateral workshops between Japan and Swiss that has been held on a yearly basis from 2009. It aims at bringing together both communities of condensed matter people (mainly theorists) working on correlated materials and related. The workshop also aims at nurturing scientic exchanges, collaborations, and friendships among young physicists between the two countries

The topics of the workshop include the following (can be extended).

- Quantum spin systems, multiferroics, and spintronics
- Topological phases of matter
- Bulk-edge(boundary) correspondence
- Dirac and Weyl fermions
- Cold atoms
- Quantum entanglement and its applications
- Many-body localization and out-of-equilibrium correlated matter
- Computational correlated physics and its methods

Organizers / Advisers

Swiss-based co-organizers
Prof. Thierry Giamarchi* (Geneva University)
Prof. Frederic Mila (EPFL)
Prof. Christopher Mudry (Paul Scherrer Institute)
Prof. Manfred Sigrist (ETHZ)

Japan-based co-organizers
Prof. Yasuhiro Hatsugai* (University of Tsukuba)
Prof. Norio Kawakami (Kyoto University)
Prof. Masao Ogata (University of Tokyo)
Prof. Hirokazu Tsunetsugu (University of Tokyo, ISSP)
(alphabetical)
*: Co-chair

Scientific advisers
Prof. Akira Furusaki (RIKEN)
Prof. Nobuo Furukawa (Aoyama Gakuin University)

Local contact
Yasuhiro Hatsugai
Email: hatsugai.yasuhiro.ge@u.tsukuba.ac.jp

Day 1. Sep. 10 (Restaurant ESPOIR)

18:00- Welcome party

Day 2. Sep. 11 Morning (room 202)

8:40-9:00 Registration

[Session 1：Chair: Akira Furusaki]

9:00-9:05 “Welcome”
Y. Hatsugai (Univ. Tsukuba)
9:05-9:35 “Chiral anomaly phenomena in Weyl superconductors”
Satoshi Fujimoto (Osaka Univ.)
9:35-10:05 “Edge states and exact zero modes in topological 1D quantum phases”
Frederic Mila(EPFL)
10:05-10:35 “Odd-parity multipole order and superconductivity in magnetoelectric materials”
Yoichi Yanase (Kyoto Univ.)

10:35-11:05 Coffee & Posters (odd numbers)

[Session 2：Chair: Norio Kawakami]

11:05-11:35 “Superconductivity in time-reversal-symmetry-broken two-dimensional systems: application to FeSe”
Mark H. Fischer (ETH)
11:35-12:05 “Magnetoelectric effects induced by spin-pair-dependent electric polarization”
Shin Miyahara (Fukuoka Univ.)
12:05-12:35 “Theory of Orbital Susceptibility in the Tight-Binding Model: Correction to the Peierls Phase and Application to Excitonic Insulator”
Hiroyasu Matsuura(Univ. Tokyo)

12:35-12:40 PHOTO
12:40-13:40 Lunch (room 201)

Day 2. Sep. 11 Afternoon (room 202)

[Session 3：Chair: Frederic Mila]

13:40-14:10 “Theory of electron spin resonance for detecting long-range spin nematic orders”
Shunsuke Furuya (RIKEN)
14:10-14:40 “The Concept of Superconducting Fitness”
Aline Ramires (ETH)
14:40-15:10 “Superlattice systems as a test bed of correlated topological classification”
Tsuneya Yoshida(Kyoto Univ.)
15:10-15:40 “Spinon confinement and field-induced transition in a quasi-1D spin system $BaCo_2V_2O_8$”
Shintaro Takayoshi (Univ. Geneva)

15:40-16:10 Coffee & Posters (even numbers)

[Session 4：Chair : Masao Ogata]

16:10-16:40 “Slightly coupled spin chains near saturation”
Noam Kestin (Univ. Geneva)
16:40-17:10 “Generalization of the Haldane conjecture to SU(3) chains”
Miklos Lajko (EPFL)
17:10-17:40 “Z_N Berry phase as an index for symmetry protected topological phases: application to one-dimensional models with SU(N) symmetry”
Toshikaze Kariyado (NIMS)

18:30- Organizer & adviser meeting

Day 3. Sep. 12 Morning (room 202)

[Session 5：Chair: Hirokazu Tsunetsugu]

9:00-9:30 “Quantum transport through one-dimensional structures”
Thierry Giamarchi (U. Geneva)
9:30-10:00 “Emergent SU(4) symmetry and spin-orbital liquids in the $ZrCl_3$ family”
Masaki Oshikawa (Univ. Tokyo)
10:00-10:30 “Parametric resonance - force sensors to new quantum phases of matter”
Ramasubramanian Chitra (ETH)

10:30-11:00 Coffee & Posters (even numbers)

[Session 6：Chair: Satoshi Fujimoto]

11:00-11:30 “Topological order in three spatial dimensions from coupled wires”
Christopher Mudry (PSI)
11:30-12:00 “Aspects of bulk boundary correspondence
in the sigma model description of SPT states”
Akihiro Tanaka (NIMS)
12:00-12:30 “Higher-order topological insulators”
Frank Schindler (UZH)

12:30-13:30 Lunch (room 201)

Day 3. Sep. 12 Afternoon (room 201)

[Session 7：Chair: Christopher Mudry]

13:30-14:00 “Order parameters for fermionic SPT phases”
Ken Shiozaki (RIKEN)
14:00-14:30 “A hidden topological surface state on nodal superconductors coexisting with antiferromagnetic order”
Shingo Kobayashi (Nagoya Univ.)
14:30-15:00 “Dirac composite fermion theory for kagome spin liquids”
Yohei Fuji (RIKEN)

15:00-15:30 Coffee & Posters (odd numbers)

[Session 8：Chair : Thierry Giamarchi]

15:30-16:00 “Nonequilibrium Bose-Hubbard model ”
Matteo Biondi (ETH)
16:00-16:30 “Quantum critical phenomena under continuous observation”
Shunsuke Furukawa (Univ. Tokyo)
16:30-17:00 “Supercurrent induced magnetic phase transition and spin-torque”
Rina Takashima (Kyoto Univ.)
17:00-17:30 “Strong Field-Induced Phase Transitions in Frustrated Quantum Magnets”
Daisuke Yamamoto (Aoyama Univ.)

18:00- Banquet (Restaurant ESPOIR)

Day 4. Sep. 13 Morning (room 202)

[Session 9：Chair: Yasuhiro Hatsugai]

8:30-9:00 “Presence and absence of thermalization in isolated quantum systems”
Tatsuhiko Ikeda (Univ. Tokyo)

9:00-9:30 “Theory of thermal transport phenomena driven by spinons, Majorana fermions, and magnon bound states”
Masahiro Sato (Ibaraki Univ.)

9:30-10:00 “A model of chiral spin liquids with Abelian and non-Abelian topological phases ”
Jyong-Hao Chen (PSI)

10:00-10:30 “Weyl superconductivity associated with phase transition of topological crystalline superconductors”
Takehito Yokoyama (Tokyo Inst. Tech.)

10:30-10:50 Coffee

[Session 10：Chair : Masaki Oshikawa]

10:50-11:20 “First-principles study of Mott physics in pyrochlore-type oxides”
Hiroshi Shinaoka (Saitama Univ.)

11:20-11:50 “Computational discovery of novel materials realizing topological electronic phases”
Oleg Yazyev (EPFL)

11:50-12:20 “Sparse modeling approach to analytical continuation and dimensionality reduction of imaginary-time Green function”
Jyunya Otsuki (Tohoku Univ.)

12:20-12:25 “Final remark”

Hirokazu Tsunetsugu (Univ. Tokyo)

12:30- “Excursion” with lunchbox

Posters:

P1 “Entanglement dynamics of free fermion systems in trapping potentials”
Isao Maruyama (Fukuoka Inst. Tech.)

P2 “Flux quench in a system of interacting spinless fermions in one dimension”
Yuya Nakagawa (Univ. Tokyo)

P3 “Thermal Hall conductivity in superconducting phase on Kagome lattice”
Shoma Iimura (Saitama Univ.)

P4 “Many-Body States of a Nearly Flat Band with Kagome Lattice”
Koji Kudo (Univ. Tsukuba)

P5 “Detection of Weyl points in mechanical diamond”
Yuta Takahashi (Univ. Tsukuba)

P6 “Section entanglement Chern number for the Fu-Kane-Mele model and the Wilson-Dirac model”
Hiromu Araki (Univ. Tsukuba)

P7 “Structural deformation and bulk-edge correspondence”
Shuhei Oono (Univ. Tsukuba)

P8 “Topological phases in multilayers of a Weyl semimetal and a normal insulator”
Kazuki Yokomizo (Tokyo Inst. Tech.)

P9 “Topological light for ultra-fast control of topological magnetic structures”
Masahiro Sato (Ibaraki Univ.)

P10 “ Fermionic partial transpose”
Ken Shiozaki (RIKEN)

P11 " Axion electromagnetics in topological magnetic insulator"
Tatsushi Imaeda (Nagoya Univ.)

P12 " Indistinguishability as non-locality constraint"
Cassio Sozinho Amorim (Nagoya Univ.)

P13 " Quantum effects on Skyrmions in two-dimensional chiral magnets"
Rina Takashima (Kyoto Univ.)

P14 " Correlation functions of the Tomonaga-Luttinger liquid with a junction"
Yoshiki Fukusumi (Univ. Tokyo)

P15 "Theory of electron spin resonance in one-dimensional topological insulators with spin-orbit couplings: Detection of edge states"
Yao Yuan (Univ. Tokyo)

P16 "First-principles study of spin-driven ferroelectricity in GaV_4S_8"
Sergey Nikolaev (NIMS)

Short abstracts (TTCM2017)

(as of September 12, 2017)

SEP. 11, 2017

SESSION 1 (9:00-10:35), CHAIR: AKIRA FURUSAKI

9:00-9:05

Welcome

Yasuhiro Hatsugai (U. Tsukuba)

9:05-9:35

Chiral anomaly phenomena in Weyl superconductors

Satoshi Fujimoto (Osaka U.)

Weyl superconductors are superconducting analogues of Weyl semimetals. There are several promising candidate materials of Weyl superconductors in heavy fermion systems such as URu2Si2, and the B-phase of UPt3, which are deemed chiral superconductors, and UCoGe, which is a spin-triplet non-unitary superconductor. Chiral anomaly in Weyl superconductors can be probed by thermal and geometrical responses induced by topological textures and dynamics of order parameters. For instance, a vortex of the superconducting order parameter gives rise to a torsional magnetic field which induces negative magnetoresistivity of thermal currents. Also, in the ferromagnetic superconductor, UCoGe, longitudinal spin fluctuations generate a dynamical axial gauge field, which couples to a vortex-induced axial magnetic field. We discuss novel chiral anomaly phenomena associated with these effects.

9:35-10:05

Edge states and exact zero modes in topological 1D quantum phases

Mila Frederic (EPFL)

Motivated by recent STM experiments on chains of Co adatoms that have revealed a series of ground state level crossings as a function of an external magnetic field, and by their possible connection to Majorana edge states, I will discuss the coupling between edge states in two topological phases of 1D quantum magnets, the transverse field Ising model, and the Haldane phase of the spin-1 chain. I will show in particular that, for a fixed length, it is possible to monitor the coupling between the edge states by inducing incommensurate correlations inside the topological phase. This can be achieved by an additional spin-spin coupling in the transverse field Ising model and by a next-nearest neighbor interaction in the spin-1 chain. This ability to monitor the coupling between the edge states allows one to induce level crossings and to realize exact zero modes in finite chains, hence to reach infinite coherence times without having to go to the thermodynamic limit, and to manipulate the edge states by changing the sign of their coupling.

10:05-10:35

Odd-parity multipole order and superconductivity in magnetoelectric materials

Yoichi Yanase (Kyoto U.)

Multipole moment, a concept established in the classical electromagnetism, characterizes the anisotropy of electric and magnetic charge distribution. Emergent multipole order in condensed matter physics has attracted fundamental interests for more than three decades. Ferroic and antiferroic order of multipole moment has been observed in many d- and f-electron systems. Although previous studies have focused on the even-parity multipole order, recent studies point to the odd-parity multipole order which may be realized in locally noncentrosymmetric systems. In this talk, we identify the odd-parity multipole order in several compounds and clarify unusual phenomena by simultaneous breaking of space inversion symmetry and time-reversal symmetry. For example, BaMn2As2 is identified as magnetopiezoelectric metal and Sr2IrO4 is shown to be a Fulde-Ferrell-Larkin-Ovchinnikov superconductor.

POSTERS & COFFEE (10:35-11:05)

SESSION 2 (11:05-12:35), CHAIR: NORIO KAWAKAMI

11:05-11:35

Superconductivity in time-reversal-symmetry-broken two-dimensional systems: application to FeSe

Mark H. Fischer (ETH)

Monolayer FeSe on SrTiO3, which exhibits high-temperature superconductivity, has recently been proposed to additionally posses (Nèel) antiferromagnetic order. This magnetic order, however, breaks both inversion and time-reversal symmetry, the two symmetries guaranteeing a weak-coupling superconducting transition in three dimensions. Motivated by this finding, I will reexamine the minimal symmetries protecting superconductivity in two dimensions and the resulting order parameters. I will show that having a combination of either symmetry with a mirror operation on the basal plane is sufficient in two dimensions and discuss a minimal model with only one of the symmetries present. Finally, I will apply these considerations to the case of FeSe. Interestingly, despite having both combined symmetries, only one superconducting state is fully stable in antiferromagnetic FeSe, namely a chiral spin-triplet order, while any phonon-mediated s-wave order is strongly suppressed by the local ordered moments.

11:35-12:05

Magnetoelectric effects induced by spin-pair-dependent electric polarization

Shin Miyahara (Fukuoka U.)

In magnetoelectric (ME) multiferroics, there is a strong coupling between magnetization M and electric polarization P. Due to the ME coupling, ME effects and electromagnon, electroactive magnon, processes arise. We investigate spin-pairs dependent electric polarization on a distorted crystal structure and show that it is given by symmetric and anti symmetric spin pair, $p^{\alpha}_{\rm S} = \Pi^{\alpha}\mathbf{S}_i \cdot \mathbf{S}_j$ and $p^{\alpha}_{\rm AS} = \sum_{\beta} d^{\alpha\beta}(\mathbf{S}_i \times \mathbf{S}_j)_{\beta}$ $(\alpha, \beta = x, y, z)$ with a vector Π^{α} and a tensor $d^{\alpha\beta}$. As a result, proper screw, canted antiferromagnetic spin structures, and up-up-down-down spin structures can couple to electric polarizations. As typical examples, we discuss static ME effects in $TbMnO_3$, $CuFeO_2$ and others.

12:05-12:35

Theory of Orbital Susceptibility in the Tight-Binding Model: Correction to the Peierls Phase and Application to Excitonic Insulator

Hiroyasu Matsuura (U. Tokyo)

An extended formula for orbital susceptibility including corrections of the Peierls phase is introduced. By using the new developed formula, we discuss the orbital susceptibility of a single-band tight-binding model on a square lattice. We clarify that the correction of the Peierls phase is comparable to the Landau-Peierls orbital susceptibility and that it corresponds to the Fermi sea term. Next, we study the orbital susceptibility of an excitonic insulator on the basis of two band model. We show that a drastic change of susceptibility as a function of temperature occurs owing to an occurrence of additional orbital susceptibility due the excitonic gap.

PHOTO (12:35-12:40)

LUNCH (RM. 201) (12:40-13:40)

SESSION 3 (13:40-15:40), CHAIR: FREDERIC MILA

13:40-14:10

Theory of electron spin resonance for detecting long-range spin nematic orders

Shunsuke Furuya (RIKEN)

Spin nematic phase is a quantum magnetic phase characterized by a quadrupolar order parameter. Since the quadrupole operators are directly coupled to neither the magnetic field nor the neutron, currently, it is an important issue to develop a method for detecting the long-range spin nematic order. In this talk I discuss that electron spin resonance (ESR) measurements enable us to detect the long-range spin nematic order. In particular, I focus on the antiferroquadrupolar order and show that the long-range antiferroquadrupolar order yields an interesting resonance peak whose resonance frequency exhibits a characteristic field dependence reflecting the condensation of bound magnon pairs.

14:10-14:40

The Concept of Superconducting Fitness

Aline Ramires (ETH)

In this talk I introduce a general scheme to probe the compatibility of arbitrary pairing states with a given normal state Hamiltonian by the introduction of a concept called Superconducting Fitness. This quantity gives a direct measure of the suppression of the superconducting critical temperature in the presence of key symmetry-breaking fields. A merit of the superconducting fitness is that it can be used as a tool to identify nontrivial mechanisms to suppress superconductivity under various external influences, in particular, magnetic fields or distortions, even in complex multiorbital systems. This concept can also be used in order to favour unusual superconducting order parameters by engineering the normal state Hamiltonian. I discuss the application of this idea to Sr_2Ru0_4, Fe-based superconductors and $CePt_3Si$.

14:40-15:10

Superlattice systems as a test bed of correlated topological classification

Tsuneya Yoshida (Kyoto U.)

Topological insulators/superconductors attract much interest because of exotic phenomena induced by topology of the wave function. One of the important issue of this field is understanding the correlation effects on the topological phases. As the result of recent extensive analysis, it is found that interaction effects can change the topological classification of free-fermions; for instance, the one-dimensional topological superconductors of class BDI follow Z classification in the absence of electron correlations, while the systems follow Z_8 classification in the presence of electron correlations. Such reduction of topological classification is extensively analyzed, and the classification for correlated systems is almost established.
However, there is still an open question to be addressed. "Which compound can be an platform of the reduction of topological classification?" In this talk, I suggest the CeCoIn5/YbCoIn5 superlattice system as a possible experimental platform of the reduction. If time allows, I also propose how to build up the platform with cold atoms.

15:10-15:40

Spinon confinement and field-induced transition in a quasi-1D spin system $BaCo_2V_2O_8$

Shintaro Takayoshi (U. Geneva)

Calculations of dynamical correlation with high precision in one-dimensional strongly correlated electron systems become possible thanks to the advance of numerical simulation techniques. We study the dynamical susceptibility of quasi-one-dimensional antiferromagnets with Ising anisotropy $BaCo_2V_2O_8$ using numerical simulations. Our numerical results can be directly compared with experimental measurements of inelastic neutron scattering and electron spin resonance. We treat the effects of interchain interaction by a mean field theory, which introduces an effective staggered field in the system. This effective field causes the confinement of spinons, an elementary excitation in Ising-Heisenberg antiferromagnets and excitation spectra are discretized. We also discuss the effect of externally applied magnetic field. The magnetic field along the anisotropy axis provokes the Zeeman splitting of transverse excitations. The magnetic field perpendicular to the anisotropy axis, on the other hand, gives rise to a quantum phase transition, which is described through a dual-field double sine-Gordon model in terms of a bosonized effective field theory.

POSTERS & COFFEE (15:40-16:10)

SESSION 4 (16:10-17:40), CHAIR: MASAO OGATA

16:10-16:40

Slightly coupled spin chains near saturation

Noam Kestin (U. Geneva)

16:40-17:10

Generalization of the Haldane conjecture to SU(3) chains

Miklos Lajko (EPFL)

Following the footprints of Haldane, we apply field theory methods to SU(3) Heisenberg chains in the fully symmetric representation, with p boxes in the Young tableau, mapping them into a flag manifold non-linear sigma model with topological angle $\theta = 2\pi p/3$. We explore the phase diagram of the sigma model using analytic calculations in the strong coupling limit and Monte Carlo simulations on lattice systems. We argue that SU(3) spin chains are gapped for $p = 3m$ but gapless for $p = 3m \pm 1$ (for integer m), corresponding to a massless critical point of the sigma model at $\theta = \pm 2\pi/3$.

17:10-17:40

Z_N Berry phase as an index for symmetry protected topological phases: application to one-dimensional models with SU(N) symmetry

Toshikaze Kariyado (NIMS)

We propose the Z_N Berry phase, i.e., the Berry phase quantized into $2\pi/N$, as an indicator for symmetry protected topological phases. The idea is demonstrated using two one-dimensional bosonic models, one with SU(3) symmetry and the other with SU(4) symmetry, where topological phases are respectively indexed by Z_3 and Z_4 Berry phases. We have to introduce an $N-1$ dimensional parameter space of local gauge twists ("synthetic Brillouin zone") to define the Berry phase, and have to use appropriate integration paths compatible with the symmetry of the system for the exact quantization into $2\pi/N$. Interestingly, the topological transitions are associated with Dirac cones or nodal lines of the energy spectra in the synthetic Brillouin zone.

DINNER (FREE TIME)

SEP. 12, 2017

SESSION 5 (9:00-10:30), CHAIR: HIROKAZU TSUNETSUGU

9:00-9:30

Quantum transport through one-dimensional structures

Thierry Giamarchi (U. Geneva)

9:30-10:00

Emergent SU(4) symmetry and spin-orbital liquids in the $ZrCl_3$ family

Masaki Oshikawa (U. Tokyo)

We propose a new mechanism by which the $SU(4)$ symmetry emerges in the limit of a strong spin-orbit coupling. The strong spin-orbit coupling in edge-sharing octahedra with a d^1 electronic configuration leads to strongly bond-dependent hopping which is apparently not $SU(4)$ symmetric. However, in α-$ZrCl_3$, a gauge transformation maps the system to an $SU(4)$-symmetric Hubbard model on the honeycomb lattice. In the strong repulsion limit at quarter filling, the low-energy effective model is the $SU(4)$ Heisenberg antiferromagnet on the honeycomb lattice, which cannot have a trivial gapped ground state and is expected to host a gapless spin-orbital liquid.

10:00-10:30

Parametric resonance –force sensors to new quantum phases of matter

Ramasubramanian Chitra (ETH)

Parametric resonance of linear harmonic oscillators is a well known phenomenon. Experimental advances in Floquet engineering in the recent past now make it possible to study parametric phenomena in a wide array of nonlinear as well as interacting systems. In this talk, I will discuss two extreme cases: parametrically modulated nonlinear classical oscillators as well as a parametrically modulated Bose-Einstein condenstate interacting with a high finesse optical cavity mode. I will show that the classical system leads to a new paradigm for a force sensor which can measure ultra weak forces whereas, the quantum many body system exhibits a new phase of matter with pulsed superradiance.

POSTERS & COFFEE (10:30-11:00)

SESSION 6 (11:00-12:30), CHAIR: SATOSHI FUJIMOTO

11:00-11:30

Non-Abelian topological phases in three spatial dimensions from coupled wires

Christopher Mudry (PSI)

Starting from an array of interacting fermionic quantum wires, we construct a family of topologically ordered states of matter in three spatial dimensions.

11:30-12:00

Aspects of bulk boundary correspondence in the sigma model description of SPT states

Akihiro Tanaka (NIMS)

As prototypes of matrix product states (MPS) and projected etangled pair states (PEPS), the Affleck-Kennedy-Lieb-Tasaki (AKLT) states for arbitrary dimensions play an instrumental role in our current understanding of entanglement properties of may body states. Rather underappreciated is the fact that a simple effective field theory description of such states, buiding on the semiclassical methods set forth by Haldane some 34 years ago, also provides insights into the same problem. Here I discuss this problem based on joint work with S.Takayoshi. Time permitting, I will mention how our study links to stochastic quantization, weak measurements, and the physics of the Unruh effect.

12:00-12:30

Higher-order topological insulators

Frank Schindler (UZH)

Three-dimensional topological (crystalline) insulators are materials with an insulating bulk, but conducting surface states which are topologically protected by time-reversal (and spatial) symmetries. Here, we extend the notion of three-dimensional topological insulators to systems that host no gapless surface states, but exhibit topologically protected gapless hinge states. Their topological character is protected by spatio-temporal symmetries, of which we present two cases:
(1) Chiral higher-order topological insulators protected by the combination of time-reversal and a four-fold rotation symmetry. Their hinge states are chiral modes and the topology is $\mathbb{Z}_2$-classified.
(2) Helical higher-order topological insulators protected by time-reversal and mirror symmetries. Their hinge states come in Kramers pairs and the topology is $\mathbb{Z}$-classified.
We provide the topological invariants for both cases and discuss possible applications.

LUNCH (RM. 201) (12:30-13:30)

SESSION 7 (13:30-15:00), CHAIR: CHRISTOPHER MUDRY

13:30-14:00

Order parameters for fermionic SPT phases

Ken Shiozaki (RIKEN)

We discuss the definitions of many body topological invariants to detect fermionic SPT phases. Our input data consist of a given pure state and symmetry operator in question. We proposed: (i) For SPT phases protected by a point group symmetry, the ground state expectation value of the "partial point group transformation" is the order parameter. (ii) For SPT phases protected by an antiunitary symmetry, the "fermionic partial transpose" combined with the unitary part of the antiunitary symmetry does simulate the partition functions on unoriented manifolds and gives the order parameter.

14:00-14:30

A hidden topological surface state on nodal superconductors coexisting with antiferromagnetic order

Shingo Kobayashi (Nagoya U.)

Over the last few years, the study on node structures in SCs has received renewed interest due to the fact that they are a kind of topological objects. In this context, the node structures are related to topology of quasiparticles in the superconducting states and ensure the existence of zero-energy Andreev bound states in the boundary. In particular, a line node induces a surface zero-energy flat band, which is observed as a zero-bias conductance peak through the tunneling spectroscopy. In this talk, we show a hidden zero-energy flat band in nodal superconductors coexisting with antiferromagnetic order.

14:30-15:00

Dirac composite fermion theory for kagome spin liquids

Yohei Fuji (RIKEN)

We propose a theoretical approach to study the quantum spin liquids in kagome antiferromagnets. In the Ising limit, spin models on the kagome lattice are formulated as a lattice gauge theory on the honeycomb lattice with bosons coupled to a gauge field. By applying a gauge mean-field approximation, the model is solved by numerical or anlytical approaches in a controlled way. By resuming the gauge fluctuation, we find two types of spin liquid on the kagome lattice: a gapped chiral spin liquid and a gapless Dirac spin liquid.

POSTERS & COFFEE (15:00-15:30)

SESSION 8 (15:30-17:30), CHAIR: THIERRY GIAMARCHI

15:30-16:00

Nonequilibrium Bose-Hubbard model

Matteo Biondi (ETH)

We study the nonequilibrium steady state of the driven-dissipative Bose-Hubbard model with Kerr nonlinearity. Employing a mean-field decoupling for the intercavity hopping J, we find that the steep crossover between low and high photon-density states inherited from the single cavity transforms into a gas-liquid bistability at large cavity-coupling J. We formulate a van der Waals like gas-liquid phenomenology for this nonequilibrium situation and determine the relevant phase diagrams, including a new type of diagram where a lobe-shaped boundary separates smooth crossovers from sharp, hysteretic transitions. Calculating quantum trajectories for a one-dimensional system, we provide insights into the microscopic origin of the bistability.

16:00-16:30

Quantum critical phenomena under continuous observation

Shunsuke Furukawa (U. Tokyo)

Recent realization of quantum gas microscopy has offered the possibility of continuously monitoring the dynamics of a quantum many-body system at the single-particle level. Here we ask how such a continuous observation influences quantum critical behavior. By analyzing effective non-Hermitian Hamiltonians for interacting bosons in an optical lattice and continuum, we demonstrate that the backaction of quantum measurement shifts the quantum critical point and gives rise to a unique one-dimensional critical phase beyond the conventional universality class [1]. We also discuss unconventional renormalization group flow in parity-time symmetric many-body systems and their realization in ultracold atoms [2].
References
[1] Y. Ashida, S. Furukawa, and M. Ueda, Phys. Rev. A 94, 053615 (2016).
[2] Y. Ashida, S. Furukawa, and M. Ueda, Nat. Comm. 8, 15791 (2017).

16:30-17:00

Supercurrent induced magnetic phase transition and spin-torque

Rina Takashima (Kyoto U.)

The proximity effect of superconductivity has renewed interest for application ranging from spintronics to topological superconductivity. In such application, efficient manipulation of magnetic moments and realizing desired magnetic orders in the presence of superconductivity are important. Here, considering the proximity effect of superconductivity in magnets, we propose spin-torques induced by a supercurrent [1-2]. We clarify remarkable advantages of supercurrent-induced torques in a domain wall manipulation compared to conventional spin-transfer torque [2]. Furthermore, we also show that a supercurrent can induce and control noncollinear magnetic orders in correlated metals with the superconducting proximity

effect [3].

[1] R.T and S. Fujimoto, Phys. Rev. B 94, 235117 (2016)
[2] R.T, S. Fujimoto, and T.Yokoyama, (preprint) cond-mat: 1706.02296
[3] R.T., Y. Kato, Y. Yanase, and Y. Motome, in preparation.

17:00-17:30

Strong Field-Induced Phase Transitions in Frustrated Quantum Magnets

Daisuke Yamamoto (Aoyama U.)

In some frustrated quantum-spin models, strong magnetic fields give rise to nontrivial quantum lifting of accidental degeneracy among classical ground states, leading to magnetic phases absent in the classical counterpart. We provide two examples that exhibit such quantum phenomena: the triangular-lattice XXZ model and the square-lattice $J_1 - J_2$ model. Under finite magnetic fields, both systems possess accidental continuous degeneracy of the classical ground states at a highly-symmetric point of the parameter space. We demonstrate that, in addition to quantum stabilization of a magnetization plateau at the point, nontrivial quantum magnetic phases emerge as a ""byproduct"" of the order-by-disorder.

BANQUET (ESPOIR) (18:00-)

SEP. 13, 2017

SESSION 9 (8:30-10:30), CHAIR: YASUHIRO HATSUGAI

8:30-9:00

Presence and absence of thermalization in isolated quantum systems

Tatsuhiko Ikeda (U. Tokyo)

Foundation of quantum statistical mechanics has recently seen a resurgence of interest partly because ultracold atomic systems serve as ideal testbeds. A key question is whether a single pure quantum state evolving unitarily can exhibit thermalization, and, if not, what kind of nonequilibrium states can be realized. In this talk, we discuss the eigenstate thermalization hypothesis, which is a widely-accepted mechanism for thermalization in generic nonintegrable systems. Then we propose, in integrable systems, a class of nonequilibrium steady states which look locally thermal but retain nonthermal nonlocal correlations.

9:00-9:30

Theory of thermal transport phenomena driven by spinons, Majorana fermions, and magnon bound states

Masahiro Sato (Ibaraki U.)

Magnetic transport phenomena are one of hottest topics in condensed matter physics, especially, in the field of spintronics. As for transport in magnetic insulators, so far most of studies have focused on magnon (spin-wave) driven dynamics. However, in addition to magnons, various quasiparticles often appear in magnets, depending on the nature of the magnetic systems. In recent years, we have theoretically and experimentally studied new magnetic transport phenomena driven by different quasiparticles: Spinon spin current in a quasi-one-dimensional magnet Sr2CuO3 [1,2], thermal current of Majorana fermions in a Kitaev candidate magnet alpha-RuCl3 [3], and thermal Hall effect driven by multiple-magnon bound states in frustrated magnets [4]. In this talk, I would like to report some essential features of these new transport phenomena.

[1] D. Hirobe, M. Sato, et al, Nature Phys. 13, 30 (2017).
[2] M. Sato, S. Maekawa and E. Saitoh, in preparation.
[3] D. Hirobe, M. Sato, Y. Shiomi, H. Tanaka, and E. Saitoh, Phys. Rev. B 95, 241112 (R) (2017).
[4] E. Takata and M. Sato, in preparation.

9:30-10:00

A model of chiral spin liquids with Abelian and non-Abelian topological phases

Jyong-Hao Chen (PSI)

We present a two-dimensional lattice model for quantum spin-1/2 for which the low-energy limit is governed by four flavors of strongly interacting Majorana fermions. We study this low-energy effective theory using two alternative approaches. The first consists of a mean-field approximation. The second consists of a Random Phase approximation (RPA) for the single-particle functions of the Majorana fermions built from their exact forms in a certain one-dimensional limit. The resulting phase diagram consists of two competing chiral phases, one with Abelian and the other with non- Abelian topological order, separated by a continuous phase transition.

10:00-10:30

Weyl superconductivity associated with phase transition of topological crystalline superconductors

Takehito Yokoyama (Tokyo I. T.)

We study topological phase transitions in a three dimensional mirror-symmetric superconductor breaking time-reversal symmetry. We construct a generic phase diagram for such a system characterized by the mirror symmetry. It is also shown that a Weyl superconducting phase generally appears between the trivial and topological crystalline superconductor phases.
We demonstrate how a trajectory of the Weyl nodes determines the change of mirror Chern numbers in the topological phase transition. We also discuss a relationship between particle-hole symmetry and the trajectory of the Weyl nodes realizing the topological crystalline superconductor phase.

COFFEE (10:30-10:50)

SESSION 10 (10:50-12:25), CHAIR: MASAKI OSHIKAWA

10:50-11:20

First-principles study of Mott physics in pyrochlore-type oxides

Hiroshi Shinaoka (Saitama U.)

Pyrochlore-type oxides are model systems for studying the effects of spin-orbital interplay and geometrical frustration. We study Mott physics and spin-orbital interplay in 5d pyrochlore iridates [1] and 3d spinel LiV2O4 [2] by means of local density approximation + dynamical mean-field theory. For the pyrochlore iridates, we map out a phase diagram with varying temperature and onsite Coulomb repulsion. We reveal the importance of strong correlation effects in compounds near a magnetic critical point. The second part is devoted to the clarification of the origin of heavy-fermion behavior in LiV2O4, which has been under debate for decades. We reveal the connection between the heavy fermion behavior and multiple Mott phases emerging from the multi-orbital aspects of the compound.
[1] H. Shinaoka, S. Hoshino, M. Troyer and P. Werner, PRL 115, 156401 (2015).
[2] H. Shinaoka, Y. Nomura, M. Harland, A. I. Lichtenstein, and S. Biermann, in preparation.

11:20-11:50

Computational discovery of novel materials realizing topological electronic phases

Oleg Yazyev (EPFL)

A large number of different topological electronic phases that can be realized in materials have been predicted recently. We have developed a first-principles methodology for identifying materials hosting various topological phases among known compounds. In my talk, I will discuss various aspects of performing such high-throughput screening relying on the Z2Pack methodology [1] and present first predictions successfully confirmed by experiments. In particular, a new Z2 topological insulator was theoretically predicted and experimentally confirmed in the β-phase of quasi-one-dimensional bismuth iodide Bi4I4 [2]. The electronic structure of β-Bi4I4, characterized by Z2 invariants (1;110), is in proximity of both the weak TI phase (0;001) and the trivial insulator phase (0;000). Our angle-resolved photoemission spectroscopy measurements on the (001) surface reveal a highly anisotropic band crossing at the M point of the surface Brillouin zone. We further predicted robust type-II Weyl semimetal phase in transition metal diphosphides MoP2 and WP2 characterized by very large momentum-space separation between Weyl points of opposite chirality [3]. A recent experimental investigation of WP2 revealed that this material shows record magnitudes of magnetoresistance combined with very high conductivity and residual resistivity ratio [4].
1. D. Gresch, G. Autès, O. V. Yazyev, M. Troyer, D. Vanderbilt, B. A. Bernevig and A. A. Soluyanov, Phys. Rev. B 95, 075146 (2017).
2. G. Autès, A. Isaeva, L. Moreschini, J. C. Johannsen, A. Pisoni, R. Mori, W. Zhang, T. G. Filatova, A. N. Kuznetsov, L. Forró, W. Van den Broek, Y. Kim, K. S. Kim, A. Lanzara, J. D. Denlinger, E. Rotenberg, A. Bostwick, M. Grioni, and O. V. Yazyev, Nature Materials 15, 154 (2016).
3. G. Autès, D. Gresch, M. Troyer, A. A. Soluyanov and O. V. Yazyev, Phys. Rev. Lett. 117, 066402 (2016).
4. N. Kumar, Y. Sun, K. Manna, V. Suess, I. Leermakers, O. Young, T. Foerster, M. Schmidt, B. Yan, U. Zeitler, C. Felser, C. Shekhar, arXiv:1703.04527.

11:50-12:20

Sparse modeling approach to analytical continuation and dimensionality reduction of imaginary-time Green function

Jyunya Otsuki (Tohoku U.)

In this talk, I address two problems in quantum many-body calculations: (1) ill-conditioned analytical continuation of imaginary-time Green functions and (2) treatment of complicated correlation functions such as the vertex part. The former reduces reliability of even highly accurate QMC data regarding dynamical properties, and the latter limits diagrammatic calculations in multiorbital systems. Our new approach based on ""sparse modeling"" resolves those problems, and enables efficient and reliable computations for strongly correlated materials.

12:20-12:25

Final remark

Hirokazu Tsunetsugu (U. Tokyo)

EXCURSION

POSTERS

P1. Entanglement dynamics of free fermion systems in trapping potentials

Isao Maruyama (Fukuoka Inst. Tech.)

P2. Flux quench in a system of interacting spinless fermions in one dimension

Yuya Nakagawa (Univ. Tokyo)

P3. Thermal Hall conductivity in superconducting phase on Kagome lattice

Shoma Iimura (Saitama Univ.)

P4. Many-Body States of a Nearly Flat Band with Kagome Lattice

Koji Kudo (Univ. Tsukuba)

P5. Detection of Weyl points in mechanical diamond

Yuta Takahashi (Univ. Tsukuba)

P6. Section entanglement Chern number for the Fu-Kane-Mele model and the Wilson-Dirac model

Hiromu Araki (Univ. Tsukuba)

P7. Structural deformation and bulk-edge correspondence

Shuhei Oono (Univ. Tsukuba)

P8. Topological phases in multilayers of a Weyl semimetal and a normal insulator

Kazuki Yokomizo (Tokyo Inst. Tech.)

P9. Topological light for ultra-fast control of topological magnetic structures

Masahiro Sato (Ibaraki Univ.)

P10. Fermionic partial transpose

Ken Shiozaki (RIKEN)

P11. Axion electromagnetics in topological magnetic insulator

Tatsushi Imaeda (Nagoya Univ.)

P12. Indistinguishability as non-locality constraint

Cassio Sozinho Amorim (Nagoya Univ.)

P13. Quantum effects on Skyrmions in two-dimensional chiral magnets

Rina Takashima (Kyoto Univ.)

P14. Correlation functions of the Tomonaga-Luttinger liquid with a junction

Yoshiki Fukusumi (Univ. Tokyo)

P15. Theory of electron spin resonance in one-dimensional topological insulators with spin-orbit couplings: Detection of edge states

Yao Yuan (Univ. Tokyo)

P16. First-principles study of spin-driven ferroelectricity in GaV_4S_8

Sergey Nikolaev (NIMS)