Poster Abstract

Main Poster Session (Nov.22, 15:30-17:30)

PS-1: **Amaha, Shinichi**

- Affiliation: ICORP-JST, Japan
- Title: **"Electronic properties of three collinear laterally coupled vertical quantum dots"**
- Abstract:

  Triple quantum dots (tQDs) attract interests on their various predicted properties, such as Kondo effect and entanglement detection, induced by their enhanced freedom of coupling manner and strength. Here we investigate experimental and theoretical studies of collinear laterally coupled vertical tQDs. Our tQDs are formed in three rectangular vertical mesa structures containing double barrier structure, aligned in a line. The measured stability diagrams indicate that the electrostatic and tunnel coupling between two adjacent dots is enough strong, but that the coupling between two dots at both ends is too small to be detected. Electronic states derived from theoretical model for our tQDs, as being related to anti-ferromagnetic order by super-exchange interaction, will be also discussed here,

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PS-2: **Kubo, Toshihiro**

- Affiliation: ICORP, JST, Japan
- Title: **"Many-body effect on coherent pseudo-spin dynamics in Aharonov-Bohm interferometer containing a laterally coupled double quantum dot"**
- Abstract:

  Time-dependent transport in mesoscopic systems have attracted a lot of interest for understanding the dynamics of quantum system. Since Loss and DiVincenzo's proposal, coherent dynamics using a single quantum dot or a double quantum dot (DQD) has been widely studied in the context of quantum computing. In a DQD with finite inter-dot tunnel coupling, we can assume that the symmetric and anti-symmetric states correspond to the pseudo-spin up and down states, respectively. Using a non-equilibrium Green's function method, we investigate the many-body effect on coherent pseudo-spin dynamics in Aharonov-Bohm interferometer containing a laterally coupled DQD. We show that the current is enhanced due to the inter-dot Coulomb interaction in a weak correlation regime

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PS-3: **Imura, Ken-Ichiro**

- Affiliation: Institute for Solid State Physics, University of Tokyo, Japan
- Title: **"Colossal spin fluctuations in a molecular quantum dot magnet"**
- Abstract:

  (Authors) Thibaut Jonckheere, Ken-Ichiro Imura and Thierry Martin
  (Abstract) We report our recent study [1] on the enhanced spin fluctuations in a molecular quantum dot with an intrinsic spin degree of freedom $\vec{s}$ coupled to two magnetic electrodes. To investigate whether we can control the molecular spin by sending current from these polarized electrodes, we calculated the average, noise and higher moments of J_z (z-component of the sum of molecular and conduction electron spins (the latter denoted by \vec{\sigma}); $\vec{j}=\vec{s}+\vec{\sigma}$, averaged during a measurement time). We focused so far on the incoherent tunneling regime, in which the average and noise can be calculated by considering a Markov chain; random sequential jumps between neighboring spin (and charge) states. [2] We found that the sum over all such possible (infinite number of) sequences combines to give an analytic expression of the J_z-noise for an arbitrary polarization P of the electrodes (actually a rational fraction of P). The J_z-noise is inversely proportional to the tunneling rate, and its amplitude is characterized by some magic numbers, which we we found to be 22/5 for $s=1/2, j=1$, 138/7 for $s=1, j=3/2$, in the case of $j=s+1/2$ spin sector in the bias window, in contrast to a considerably smaller value 1/3 for a usual quantum dot ($s=0, j=1/2$). We also reproduced all these results by an alternative method, employing a generating function obtained by solving an eigenvalue problem of the Master equation with a counting field for J_z. [3] We also calculated the third and fourth order cumulants for $s=0, 1/2, 1, \cdots$.

  [1] T. Jonckheere, K.-I. Imura and T. Martin, in preparation.
  [2] A. N. Korotkov, Phys. Rev. B 49, 10381 (1994).
  [3] K.-I. Imura, Y. Utsumi and T. Martin, Phys. Rev. B 75, 205341 (2007)

PS-4: **Utsumi, Yasuhiro**

- Affiliation: RIKEN, Japan
- Title: **" Full Counting Statistics for Number of Electrons Dwelling in a Quantum Dot"**
- Abstract:

Motivated by recent real-time electron counting experiments, we evaluate the full counting statistics (FCS) for the probability distribution of the electron number inside a quantum dot which is weakly coupled to source and drain leads. A non-Gaussian exponential distribution appears when there is no dot state close to the lead chemical potentials. We propose the measurement of the joint probability distribution of current and electron number, which reveals correlations between the two observables. We also show that for increasing strength of tunneling, the quantum fluctuations qualitatively change the probability distribution of the electron number. In this paper, we derive the cumulant generating functions (CGFs) of the joint probability distribution for several cases. The Keldysh generating functional approach is adopted to obtain the CGFs for the resonant-level model and for the single-electron transistor in the intermediate conductance regime. The general form for the CGF of the joint probability distribution is provided within the Markov approximation in an extension of the master equation approach [D. A. Bagrets, and Yu. V. Nazarov, Phys. Rev. B {\bf 67}, 085316 (2003)]

PS-5: **Osawa, Kentaro**

- Affiliation: Department of Physics, Waseda university, Japan
- Title: **"Fano effect in a Josephson junction"**
- Abstract:

A system consisting of an Aharonov-Bohm ring and a quantum dot (AB-QD system) is being studied energetically. In this system, the interference between continuum and discrete levels causes asymmetric line shape of the conductance-gate voltage characteristic (Fano effect). So far, studies of the Fano effect have been focused only on normal metal systems and there are not enough studies in superconducting systems.
In our study, we investigate the influence of the Fano effect on a Josephson current in a superconducting AB-QD system. We treat the coulomb interaction in QD within the Hartree-Fock approximation and calculate the Josephson current.

PS-6: **Kamide, Kenji**

- Affiliation: Waseda University, Japan
- Title: **"Scaling of an impurity potential of arbitrary strength in a spinful Tomonaga-Luttinger liquid"**
- Abstract:

Transport through a Tomonaga-Luttinger liquid (TL liquid) with spin in presence of a single impurity is studied. An open boundary bosonization technique is developed to include the impurity potential of arbitrary strength. Our new bosonic representation of the fermionic field operator smoothly connects the existing bosonization formula in the two limits, the strong impurity (V->¥infty) and weak impurity (V->0) [1]. Using the fermionic field operator, various correlation functions are calculated. From the scaling dimensions of local density of states (LDOS) at the impurity and far from the impurity, we evaluate the renormalization of the impurity potential based on a conjecture: the enhancement of LDOS at the impurity means the enhancement of the electron transmission amplitude, and the suppression of LDOS means the enhancement of electron backscattering amplitude. In addition, the scaling dimensions of correlators in the bulk region (far from the impurity) also depend on the impurity strength, meaning the TL parameters are also renormalized as well as the impurity potential. These results give the overall explanation to the shift of the phase boundary from the weak reflection to the weak tunneling limit, which is given by Kane and Fisher [2].
References:
[1] K. Kamide, Doctor thesis (Chap. 4), Waseda University, (2007)
[2] C. L. Kane and M.P.A. Fisher, Phys. Rev. Lett. 68, 1220 (1992): Phys. Rev. B 46, 15233 (1992)

PS-7: **Nakajima, Chihiro**

- Affiliation: Kyoto Univiersity, Japan
- Title: **"Electron transport driven by a chemical potential"**
- Abstract:

Based on Bhatnagar-Gross-Krook equation coupled with Maxwell equation,
we investigate the spatial dependence of a chemical, an electrostatic and an electrochmeical potentials inside a specimen connected with reservoirs.
We also confirm that a gap of the chemical potential between at a connection point is negligible

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PS-8: **Nakamura, Hiroaki**

- Affiliation: National Institute for Fusion Science, JAPAN
- Title: **"Quasi-bound state in continuum of a two-channel quantum wire with an adatom"**
- Abstract:

The resonance states with complex energy eigenvalues are discussed for a ladder system with an adatom in a semiconductor low-dimensional superlattice. We have found that some resonant states have a very small imaginary part of the eigenenergy in the overlapped region of two continuous-energy

bands from each leg of the ladder model. We call these states QBIC (quasi-bound states in continuum). The QBIC exists for a wide range of the physical parameters of the system (i.e., nonzero measure) in contrast to the well-known bound state in continuum (BIC) that exists only at discrete points with zero measure in the parameter space. Since the resonance state does not belong to the Hilbert space (the state diverges in configuration space), it is usually difficult to evaluate this state by numerical calculation. We propose a numerical method to evaluate the resonance state with great accuracy.

PS-9: **Hatano, Naomichi**

- Affiliation: Institute of Industrial Science, University of Tokyo, Japan
- Title: **"Non-Abelian gauge field theory of the spin-orbit interaction and a perfect spin filter"**
- Abstract:

  We point out that the Rashba and Dresselhaus spin-orbit interactions in two dimensions can be regarded asa Yang-Mills non-Abelian gauge field. The physical field generated by the gauge field gives the electron wave function a spin-dependent phase which is frequently called the Aharonov-Casher phase. Applying on an AB ring this non-Abelian field together with the usual vector potential, we can make the interference condition completely destructive for one component of the spin while completely constructive for the other component of the spin over the entire energy range. This enables us to construct a perfect spin filter

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PS-10: **Onoda, Shigeki**

- Affiliation: RIKEN, JAPAN
- Title: **"Interplay between topological Hall current and disorder in clean to localized ferromagnets"**
- Abstract:

  The mechanism of the anomalous Hall effect and the related transport phenomena in ferromagnets has been an intriguing but controvertial issue in condensed-matter physics for many decades. Particularly, it has been required to understand the fate of the dissipationless topological nature of the Hall effect in the presence of impurities and/or disorder, from both theoretical and experimental viewpoints. Here, I present quantum transport theories of electric, thermoelectric, and thermal Hall effects in ferromagents.

  (I) The self-consistent T-matrix approximation for the metallic regime with low impurity concentrations reveals two crossovers among the three regimes as a function of the relaxation rate $\hbar/\tau$.
  (i) The Mott scattering, i.e., the skew scattering, gives the leading contribution to the anomalous Hall conductivity σ_{xy} in the superclean case, which diverges in proportion to τ in the clean limit.
  (ii) In modarately dirty system where $\hbar/\tau$ is larger than the spin-orbit interaction energy, the skew-scattering contribution rapidly decays and the intrinsic topological contribution becomes dominant.
  (iii) In dirty metals where $\hbar/\tau$ is larger than the Fermi energy, another scaling behavior of $\sigma_{xy}\propto\sigma_{xx}^{1.6}$ appears, which has recently been verified by extensive experimental studies. Similar behaviors are also found in the anomalous Nernst effect.

  (II)The numerical study for the localized regime is also presented. In particular, I discuss a possibility of the anomalous Hall insulator recently discovered by experiments.<br

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PS-11: **Obuse, Hideaki**

- Affiliation: RIKEN, Japan
- Title: **"Conformal Invariance at the Anderson Transition in the Two-Dimensional Systems with Spin-Orbit Interactions"**
- Abstract:

  In two dimensions the universal critical properties at conventional continuous phase transitions are known to be described by conformal field theories. In contrast, for continuous phase transitions driven by disorder, field theories that have a power of predicting critical properties are still missing even in two dimensions. The Anderson metal-insulator transition of a non-interacting in random potential is one such example of a disorder-driven quantum phase transition lacking satisfying theoretical description. In this work we present direct evidence for the presence of conformal invariance at the Anderson transition in the two-dimensional disordered system with spin-orbit interactions. This can be viewed as a first step toward establishing a conformal field theoretical description of the Anderson transition in two dimensions.

  It is well known that moments of wave functions at critical points of Anderson transitions show multifractality reflecting absence of characteristic length scale in the system. In this work we consider multifractality at straight boundaries (surface multifractality) and at corners with wedge angle θ (corner multifractality). We numerically calculate multifractal singular spectra $f(\alpha)$ and anomalous dimensions Δ_q for surface and corner region of two-dimensional samples of the so-called SU(2) model which is a tight-binding model with random on-site disorder and spin-flip hopping. We show that the corner multifractal spectra and anomalous dimensions are directly related, through simple relations arising from conformal invariance, to surface multifractal spectra and anomalous dimensions,

respectively.

PS-12: **Shirasaki, Ryoen**

- Affiliation: Faculty of Engineering, Yokohama National University, Japan
- Title: **"Fundamental relation between the transport coefficients in the Quantum Hall system"**
- Abstract:

  We study the transport coefficients of the two dimensional electron gas in a strong magnetic field and newly propose the fundamental relation between them. The transport coefficients are calculated by using the current-current correlation functions adopting the Green's function method. Strictly calculation is possible by introducing the self-energy part in the Green's function as the constant and by neglecting the vertex correction. Simple relation, for example, between the resistivity and the hall coefficient is derived, comparing the magnetic field dependency of the transport coefficients.<br

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PS-13: **Tsuda, Kazumi**

- Affiliation: Theoretical particle physics group, Deperment of Physics, Hokkaido University, Japan
- Title: **"Hall conductivity of two dimensional charge density wave and bubble states"**
- Abstract:

  We study the Hall conductivity of two dimensional charge density wave (CDW) and bubble states in higher Landau levels. In both states, a periodic potential is generated self-consistently. If the state is pinned by disorder, the self-consistently generated potential could be regarded as an external periodic potential, in which case, the Hall conductivity would be quantized at an integer value. The reentrant integer quantum Hall effect observed in higher Landau levels has been explained by this claim qualitatively. We confirm the quantization of the Hall conductivity by the Kubo formula and calculate the integer value for the CDW and the bubble states at several filling factors. It is found that the Hall conductivity takes the integer value nearest to the filling factor except for highly anisotropic CDW states, which takes a next nearest integer value. We also calculate the Hall conductivity of unpinned states in the absent of impurities and compare the results. The diagonalization technique of the Hartree-Fock Hamiltonian using the von Neumann lattice base (K.Tsuda, N.Maeda, and K.Ishikawa, Phys. Rev. B 76, 045334 (2007)) is used in our calculation.

PS-14: **Sasaki, Shosuke**

- Affiliation: Shizuoka Institute of Science and Technology, Japan
- Title: **"Frequency Dependence of Diagonal Resistance in Fractional Quantum Hall Effect via Periodic Modulation of Magnetic Field "**
- Abstract:

  Energy spectrum of fractional quantum Hall (FQH) states is composed of single electron energy (Landau energy) neglecting the Coulomb interactions between electrons, classical Coulomb energy and the quantum energy via quantum transitions. Herein, the sum of the Landau energy and the classical Coulomb energy depends upon the value of the filling factor continuously. However, the quantum transition energy discontinuously depends upon the value of the filling factor. This discontinuity yields energy gaps in many stable FQH states. The energy gaps for specific filling factors produce the precise confinement of Hall resistance.
  A new experiment is considered as follows; the magnetic strength is fixed to the value to confine the Hall resistance at the filling factor of 2/3 as an example. Moreover the magnetic modulation with frequency f is added to the system. The frequency dependence of the diagonal resistance is measured. Then, it is shown in this paper that the diagonal resistance varies drastically at some frequency value f0. We clarify the following relation between this value f0 and the magnetic strength width dB of Hall plateaus as f0 = e dB / (4 Pi m), where -e is the charge of electron, Pi =3.141592, and m is the mass of electron

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PS-15: **Hida, Kazuo**

- Affiliation: Division of Material Science, Graduate School of Science and Engineering, Saitama University, Japan
- Title: **"Frustration Induced Noncollinear Ferrimagnetism in Mixed Spin Chain with Frustrated Side Chain"**
- Abstract:

  Ferrimagnetic ground states of the mixed spin Heisenberg chains with frustrated side chain are investigated by means of the numerical exact diagonalization and DMRG method. In addition to the Lieb-Mattis type ferrimagnetism in which the spontaneous magnetization is given by the difference of fully polarized sublattices, a noncollinear ferrimagnetsim with spontaneous magnetization is not a simple fraction of full magnetization is found between Lieb-Mattis type phase and nonmagnetic phase. It turns out that the spin profile has incommensurate structure as in the previously reported frustration induced noncollinear ferrimagnetism. Exotic nonmagnetic phases which appear around this ferrimagnetic phase

will be also discussed

PS-16: **Sakai, Toru**

- Affiliation: Japan Atomic Energy Agency, Japan
- Title: **"Quantum phase transitions in spin nanotubes"**
- Abstract:

  Recently some quantum spin systems on tube lattices, so called spin nanotubes, have been synthesized [1, 2]. It would be possibly a new type of low-dimensional magnet towards a fruitful application in the nanoscience and technology, like the carbon nanotube. As a first step of theoretical study on the spin nanotube, we investigate the S=1/2 three-leg spin tube, which is the simplest one, using numerical diagonalization, density matrix renormalization group calculation of finite clusters and a finite-size scaling technique.

  The spin gap, which is one of the most interesting quantities reflecting the macroscopic quantum effect, was revealed to be open for any finite rung exchange couplings, in contrast to the three-leg spin ladder system which is gapless. In the previous study [3], we also found a quantum phase transition caused by an asymmetric rung interaction. When one of the three rung coupling constants is changed, the spin gap vanishes very rapidly. In the present study, estimating the critical exponent of the spin correlation function and the central charge of the conformal field theory, we reveal that the quantum phase transition belongs to the same universality class as the Berezinskii-Kosterlitz-Thouless transition. The phase diagram in the ground state is also presented by the recently developed level spectroscopy method applied to the low-lying excitations of finite-size systems. In addition we mention some new field-induced quantum phase transitions[4].

  [1] J. Schnack, H. Nojiri, P. Koegerler, G. J. T. Cooper and L. Cronin: Phys. Rev. B {\bf 70} (2004) 174420.

  [2] R. Kitaura, S. Kitagawa, Y. Kubota, T. C. Kobayashi, K. Kindo, Y. Mita, A. Matsuo, M. Kobayashi, H.-C. Chang, T. C. Ozawa, M. Suzuki, M. Sakata and M. Takata: Science 298 (2002) 2358.

  [3] T. Sakai, M. Matsumoto, K. Okunishi, K. Okamoto and
  M. Sato: Physica E 29 (2005) 633.

  [4] M. Sato and T. Sakai: Phys. Rev. B 75 (2007) 014411-1-5.

PS-17: **Sato, Masahiro**

- Affiliation: Condensed Matter Theory Laboratory, RIKEN, Japan
- Title: **"Vector chiral order in one-dimensional quantum spin systems"**
- Abstract:

  We have theoretically studied mechanisms of vector chiral order in one-dimensional (1D) quantum spin systems. The emergence of vector chiral order is generally forbidden in 1D "isotropic" spin systems. However, if a magnetic field is applied in the systems, the vector chiral order parallel to the field can be allowed. Actually we have shown that a magnetic field can induce a vector chiral order in two types of isotropic spin systems: triangular spin tubes and two-leg spin ladders with four-spin exchanges. I will talk about these new mechanisms

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PS-18: **Takano, Ken'ichi**

- Affiliation: Toyota Technological Institute, Japan
- Title: **"Effect of Side Chain for a Spin Chain"**
- Abstract:

  We study a quantum spin chain with side chain where frustration exists. The ground state properties are examined by a nonlinear sigma model method and a numerical diagonalization. We present the condition that a disordered ground state appears. A phase transition between different disordered states are discussed.

PS-19: **Momoi, Tsutomu**

- Affiliation: Condensed Matter Theory Laboratory, RIKEN, Japan
- Title: **"Nematic and Multipolar Orders in Frustrated Magnets"**
- Abstract:

  We discuss the appearance of new quantum phases in frustrated magnets with strong ferromagnetic fluctuations and present a new scenario for the breakdown of ferromagnetic order, which gives rise to "spin liquid" phases with hidden magnetic multipolar orders. Dynamical effects lead to the formation of magnon bound states, which undergo Bose-Einstein condensation. This scenario is explored in some

detail for an extended Heisenberg model on a square lattice, a triangular lattice, and a zigzag chain.

On a square lattice, two-magnon bound states are most stable, giving rise to bond-centered spin nematic - i.e. quadrupolar - order but no long range spin order. On a triangular lattice, three-magnon bound states are most stably formed, leading to a gapless spin liquid with hidden octupolar order in applied magnetic field, in a model applicable to thin films of solid He3. On a zigzag chain, various multimagnon bound states appear one after another with varying parameters. Bose condensation of the bound n magnons leads to novel Tomonaga-Luttinger liquids with multipolar correlations

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PS-20: **Oyamada, Akira**

- Affiliation: Kyoto University, Japan
- Title: **"NMR Study of a Kagome ice compound Co_2_(OH)_3_Cl"**
- Abstract:

  In a hydroxyhalide Co_2_(OH)_3_Cl, Co^2+^ ions form alternative stacking layers of triangular and Kagome lattice planes. Below 10 K, only Co^2+^ moments on the triangular lattice plane orders ferromagnetically and moments on the Kagome lattice plane remains disorderd. The similarity of this partial order to the Kagome ice state attracts much attention recently. We have measured ^1^H NMR spectra and relaxation rate T_1_^-1^ to investigate the spin dynamics of Co^2+^ moments. The temperature dependence of T_1_^-1^ shows that the short range correlations start to develop from 300 K and the largeness of T_1_^-1^ suggests the slow dynamics of frustrated Co^2+^ moments

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PS-21: **Miyahara, Shin**

- Affiliation: ERATO-MF, JST, Japan
- Title: **"The strong correlation limit for a triangular t-V model"**
- Abstract:

  In the frustrated electron system, the applicable numerical methods are limited. Exact diagonalization method is a useful technique even in the frustrated system, although the system size is small. To realise the exact diagonalization calculation in larger system sizes, we develop a new technique using the projection to the ground state in the strong correlation limit. The triangular t-V model in the strong correlation
  limit is equivalent to the Ising model, and the ground state is macroscopically degenerate. Within the Hilbert space projected onto the degenerate ground state in the strong correlation limit, we can treat the much larger system sizes compared with the usual exact diagonlization method. Using this technique, we discuss the anomalous ground state called pinball liquid. <br

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PS-22: **Pollmann, Frank**

- Affiliation: Max-Planck-Institut fuer Physik komplexer Systeme, Germany
- Title: **"Itinerant electrons on geometrically frustrated lattices."**
- Abstract:

  We study a novel class of systems with electronic degrees of freedom on frustrated lattices. It has been shown that such systems can have excitations which carry fractional charges (e/2) in the limit of strong correlations [1]. In order to understand the mechanism and physical properties of these fractionalized charges, we firstly consider a model of spinless fermions on a geometrically frustrated checkerboard lattice. An effective Hamiltonian is derived which describes the low-lying excitations in the limit of strong correlations. The ground state of the latter Hamiltonian is shown to be charged ordered and the fractional charges are linearly confined [2]. Secondly, we consider a model of "Spinful" fermions on a kagome lattice and study the interplay between charge- and spin-degrees of freedom. In particular, we find here a new mechanism yielding ferromagnetism [3].

  [1] P. Fulde and K. Penc and N. Shannon, Ann. Phys. (Leipzig) 11, 892 (2002)
  [2] F. Pollmann and P. Fulde, Europhys. Lett. 75, 133 (2006)
  [3] F. Pollmann, P. Fulde, and K. Shtengel, arXiv:0705.3941 (2007)

PS-23: **Furukawa, Shunsuke**

- Affiliation: Condensed Matter Theory Laboratory, RIKEN, Japan
- Title: **"Systematic Derivation of Order Parameters through Reduced Density Matrices"**
- Abstract:

  A systematic method for determining order parameters for quantum many-body systems on lattices is developed by utilizing reduced density matrices. This method allows one to extract the order parameter directly from the wave functions of the degenerate ground states without aid of empirical knowledge, and thus opens a way to explore unknown exotic orders. The applicability of this method is demonstrated numerically or rigorously in models which are considered to exhibit dimer, scalar chiral, and topological orders

PS-24: **Sagane, Tami**

- Affiliation: Graduate School of Human and Environmental Studies, Kyoto Univ., Japan
- Title: **"Nuclear Magnetic Relaxation in Nanoscale Molecular Antiferromagnets"**
- Abstract:

Nanoscale molecular magnets with a finite number of spins show characteristic relaxation mechanism due to the discrete energy levels, unlike bulk magnets with the continuous energy levels. We have performed NMR measurements in a molecular antiferromanget Fe12 and observed the peak of the nuclear spin-lattice relaxation rates at a temperature corresponding to the order of the exchange interaction J. This peak is analogous to the one in other molecular antiferromagnetic rings, Cr8, Fe6 and Fe10, and is explained to be dominated by the lifetime of the energy levels caused by the spin-phonon interaction. However, the frequency dependence of the relaxation rates in Fe12 cannot be explained from this model. The antiferromagnetic correlation is considered to play an important role on this nanomagnetic system

PS-25: **Machida, Masahiko**

- Affiliation: CCSE, Japan Atomic Energy Agency, Japan
- Title: **"Parallel DMRG Studies for n-leg Hubbard Model: Stripe Formation and its Transformation "**
- Abstract:

We parallelize density-matrix renormalization group (DMRG) to directly extend it to 2-dimensional (n-leg) quantum lattice models. The parallelization is made mainly on the exact diagonalization for the superblock Hamiltonian since the part requires an enormous memory space as the leg number n increases. The superblock Hamiltonian is divided into three parts, and the correspondent superblock vector is transformed into a matrix, whose elements are uniformly distributed into processors. The parallel efficiency shows a high rate as the number of the states kept m increases, and the eigenvalue converges within only a few sweeps in contrast to the multichain algorithm. By using the parallel DMRG, we confirm in the repulsive 2-D Hubbard model that the stripe observable in the hole density profile is not artificial because the spin-density modulation as its counterpart disappears with increasing m according to Lieb-Mattis theorem. Moreover, we find that the stripe transforms with changing U/t. In the presentation, we will show systematic results for the stripe formation and its transformation in various hole-doping range.

PS-26: **Shinaoka, Hiroshi**

- Affiliation: Univ. Tokyo, Japan
- Title: **"Mean-field studies on disordered Hubbard model"**
- Abstract:

A disordered Hubbard model is one of the simplest models for coexisting interactions and randomness in itinerant systems. We focus on singularities of thermodynamic quantities expected at metal-insulator transitions or those expected within glassy phases. Our motivation is as follows: (i) How do interactions affect Anderson transition? (ii) Which type of singularity appears in thermodynamic quantities of glassy phases? For these purposes, by using the Hartree-Fock approximation, we have obtained the ground-state phase diagram of the model, containing antiferromagnetic insulating/metallic, paramagnetic metallic and Anderson insulating phases. We have also found a pseudo-gap behavior of density of states in the Anderson insulating phase. In the presentation, we show the whole ground-state phase diagram and discuss the origin of the pseudo-gap behavior.

PS-27: **Misawa, Takahiro**

- Affiliation: Department of Applied Physics, University of Tokyo, Japan
- Title: **"YbRh2Si2: quantum tricritical behavior in itinerant electron systems"**
- Abstract:

We clarify the criticality of the quantum tricritical point (QTCP) in itinerant electron systems. QTCP is the quantum critical point where a continuous phase transition changes into a first-order one at zero temperature. We consider the QTCP in itinerant antiferromagnet under external magnetic fields. A striking feature of QTCP is that not only the antiferromagnetic susceptibility but also the ferromagnetic susceptibility diverges under the magnetic field. We show that the criticality of QTCP consistently explains otherwise puzzling features of heavy fermion compound YbRh2Si2 observed in experiments. In particular, the singularities of the ferromagnetic susceptibility and the magnetization curve at the QTCP account for anomalous experimental results.

PS-28: **Yamaji, Youhei**

- Affiliation: Department of Applied Physics, University of Tokyo, Japan
- Title: **"Quantum Metamagnetic Transitions Induced by Changes in Fermi-Surface Topology"**

- Abstract:

  We clarify that metamagnetic transitions in two and three dimensions show unusual properties as quantun phase transitions if they are accompanied by changes in Fermi-surface topology. An unconventional universality deeply affected by the topological nature of Lifshitz-type transitions emerges around the marginal quantum critical point (MQCP). Here, the MQCP is defined by the meeting point of the finite temperature critical line and a quantum critical line running on the zero temperature plane. The MQCP offers a marked contrast with the Ising universality and the gas-liquid-type criticality satisfied for conventional metamagnetic transitions. At the MQCP, the inverse magnetic susceptibility has a diverging slope as a function of the magnetization, which should not occur in any conventional quantum critical phenomena. The exponent of the divergence can be estimated even at finite temperatures. We propose that, around the MQCP, not only the magnetic susceptibility but the charge compressibility also diverges and affects the so-called non-Fermi-liquid behaviors. We also propose that such an unconventional universality indeed accounts for the metamagnetic transitions in the cubic itinerant ferromagnet ZrZn_{2}

PS-29: **Chainani, Ashish**

- Affiliation: The Institute of Physical and Chemical Research(RIKEN) at Spring 8, Japan
- Title: **"Evidence for charge-order maximized momentum-dependent superconductivity : Angle-resolved Photoemission spectroscopy of 2H-NbSe2:"**
- Abstract:

  Abstract : Charge ordering and superconductivity are observed in the phase diagrams of a variety of materials such as NbSe3, layered transition metal dichalcogenides and high-Tc cuprates, low-dimensional organics, Ba1-xKxBiO3, etc. While both, conventional charge density wave (CDW) transitions as well as superconductivity show an energy gap in the single particle density of states at the Fermi level (EF), their physical properties are poles apart : insulating behavior for CDW and zero resistivity in superconductors. Consequently, these two ground states are believed to compete with each other. In an earlier study, we showed that the momentum dependence of the superconducting gap exhibits FS sheet-dependent superconductivity in this low-transition temperature system[1]. In this work, we show that across TCDW ~ 33 K, the CDW order occurs at specific momentum(k)-points on FSs in the 2-D Brillouin zone with spectral weight suppression, but no insulating gap formation. Across Tc = 7.2 K, we obtain evidence for maximized superconductivity at points in k-space which are directly connected by the CDW ordering vector. Temperature-dependent angle-resolved photoemission spectroscopy (ARPES) of 2H-NbSe2 across the CDW and superconducting transitions (TCDW ~ 33 K and Tc = 7.2 K, respectively) show CDW-induced spectral-weight depletion at the same Fermi surface (FS) crossing k points which evolve into the largest superconducting gaps. These k-points also exhibit the highest electron-phonon coupling and lowest Fermi velocities. The present results demonstrate charge order can maximize superconductivity in an electron-phonon coupled system, in direct contrast to the prevailing view that it only competes with superconductivity[2].

  [1] T. Yokoya, T. Kiss, A. Chainani, S. Shin, M. Nohara and H. Takagi, Science 294, 2518(2001).
  [2] T. Kiss, T. Yokoya, A. Chainani, S. Shin, T. Hanaguri, M. Nohara and H. Takagi (accepted in Nature Physics).<br

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PS-30: **Itou, Tetsuaki**

- Affiliation: Graduate School of Human and Environmental Studies, Kyoto Univ, Japan
- Title: **"NMR study of a layered organic conductor EtMe_3_P[Pd(dmit)_2_]_2_ : Connection between spin-gapped Mott insulator and superconductivity"**
- Abstract:

  An organic spin-gapped Mott insulator, EtMe_3_P[Pd(dmit)_2_]_2_, shows superconductivity under a pressure of a few kbars. We have investigated the phase diagram of this system by 13C NMR measurements under pressures. We have confirmed that the nonmagnetic phase persists to the Mott transition to the metallic and superconducting phases, without the appearance of a long-range magnetic ordered phase. Thus, the superconductivity exists on the border of the spin-gapped Mott insulator. This is different from other superconductivities in correlated-electron systems, which are usually situated nearby long-range magnetic ordered states. In the metallic state of this system, the Korringa relation (1/(T1T)=const.) is observed, suggesting the Fermi-liquid like low-energy excitation.

PS-31: **Mochizuki, Masahito**

- Affiliation: JST, Tokura ERATO Multiferroics Project c/o Dept. of Applied Physics, University of Tokyo, Japan
- Title: **"Orbital Physics and Phase Diagrams of the Cobalt-Oxide Superconductor"**
- Abstract:

  The orbital physics of superconductors with strongly correlated electrons remains to be one of the unexplored fields of the condensed-matter physics. This is mainly because there has been no established example of the multiorbital superconductor. We argue that in the recently discovered sodium cobalt oxyhydrate NaxCoO2.yH2O, the Co t_{2g} orbitals play essential roles on the

mechanism and properties of its superconductivity, and this material, thus, provides a precious example of the long-desired multiorbital superconductor. We review recent developments of theoretical studies, which focus on the orbital degrees of freedom, and also related experimental studies. We particularly focus on experimentally obtained phase diagrams, which reveal that superconducting and magnetic properties of the present cobaltate are sensitively controlled by the CoO2-layer thickness owing to the orbital-lattice coupling. By constructing and analyzing multiorbital models, we study effects of the CoO6 lattice distortion. We reproduce the phase diagrams, and propose that two different superconducting states, i.e. a spin-singlet extended s-wave pairing and a spin-triplet p-wave pairing, on different types of Fermi surfaces are possibly realized. In particular, the latter p-wave pairing was stabilized by ferromagnetic fluctuations induced by the interorbital Hund's-rule coupling. By microscopically calculating thermodynamic quantities, we show that controversial and inconsistent results of several thermodynamic measurements can be well understood if we consider these two kinds of superconducting states. Through this discussion, we propose several fascinating properties, pairing mechanisms, and phenomena originating from the orbital-lattice coupling, the Hund's-rule coupling, the spin-orbit interaction, and the multiband superconducting gap, which are inherent in the multiorbital systems, and can never been expected in usual single-band superconductors like high-Tc cuprates and organics. We point out that this cobaltate system can be a key material for studying the orbital physics in the strongly correlated superconductors

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PS-32: **Udagawa, Masafumi**

- Affiliation: University of Tokyo, department of engineering, JAPAN
- Title: **"Charge Ordering and Non-equilibrium Phenomena in Quasi-2D Organic Conductors"**
- Abstract:

  Recently, considerable attention has been focused on quasi-2D organic conductor, (BEDT-TTF)$_2$X. In particular, θ-type compounds with X=MM'(SCN)_4$ exhibit intriguing behavior. Here M(=Tl, Rb or Cs) modulates dihedral angle between neighboring BEDT-TTF molecules in each layer, resulting in systematic change in charge ordering phenomena. For M=Rb and Tl, charge ordering takes place below 250K and 190K, respectively. While for M=Cs, long-range charge order is suppressed, but X-ray diffraction data indicate two diffuse spots at low temperatures, suggesting that short-range charge modulations with different wave vectors coexist. Interestingly, anomalous transport phenomena such as strongly non-linear I-V characteristics and large magneto-resistance have been reported for the Cs compound. In the same family of compounds with θ-type structure, similar but different non-equilibrium property has also been found in the melting of charge order by electric field. A relation between these transport properties and charge fluctuations is under debate. In this contribution, we report our theoretical results on the origin of the coexisting charge fluctuations by the random phase approximation for the extended Hubbard model on an anisotropic triangular lattice including electron-phonon couplings[1]. Our results successfully reproduce the experimental phase diagram and the charge fluctuations in the critical region. We clarify the mechanism of the coexistence by focusing on the roles of electron correlation and phonons, which leads to a natural interpretation of contrastive temperature dependence of the coexisting charge fluctuations observed in experiments. We also discuss the non-equilibrium phenomena under electric field, in connection with our analyses on the charge fluctuations.

  [1]M. Udagawa and Y. Motome, Phys. Rev. Lett., 98, 206405 (2007

PS-33: **Kondo, Mima**

- Affiliation: Graduate Scool of Human and Environmental Studies, Kyoto Univ., Japan
- Title: **"NMR measurements on single crystals of 5f-electron triangular antiferro. UNi_4_B"**
- Abstract:

  A triangular heavy fermion antiferromagnet UNi_4_B exhibits a partially disordered state, in which two-thirds of U 5f moments order in a vertex-like structure and one-third of U 5f moments remain paramagnetic. We have measured ^11^B NMR spectra and relaxation time T_1_ on single crystals of UNi_4_B in order to study the magnetic structure and spin dynamics. The proposed magnetic structure is not consistent with the NMR spectra. Therefore the reexamination of the magnetic structure of this compound is required.

PS-34: **Matsumoto, Munehisa**

- Affiliation: ETH Zurich, Switzerland
- Title: **"Quantum Monte Carlo study of dissipative granular arrays"**
- Abstract:

  We discuss the on-site charging energy of the dissipative granular arrays by the quantum Monte Carlo method, focusing on its dependence on the strength of dissipation in comparison to several theoretical predictions.
  The problem in the simulation of dissipative granular array arises from the fact that its action has both of the phase difference terms and the on-site charging energy terms. We utilize an algorithm with which the action is divided into two kinds of terms, namely the on-site terms and the inter-site terms, and a

cluster-update scheme for the latter is combined with the Metropolis method for the former part of the action. With this algorithm, the on-site charging energy is determined precisely.<br

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PS-35: **Capponi, Sylvain**

- Affiliation: Unversity of Toulouse, France
- Title: **"Molecular superfluid phase in one-dimensional multicomponent fermionic cold atoms"**
- Abstract:

  We study a simple model of N-component fermions with contact interactions which describes fermionic atoms with $N=2F+1$ hyperfine states loaded into a one-dimensional optical lattice. We show by means of analytical and numerical approaches that, for attractive interaction, a quasi-long-range molecular superfluid phase emerges at low density. In such a phase, the pairing instability is strongly suppressed and the leading instability is formed from bound-states made of N fermions.

PS-36: **Goryo, Jun**

- Affiliation: Aoyama Gakuin University, Japan
- Title: **"Anomalous vortex state in the thin film of two-gap superconductors "**
- Abstract:

  We discuss the vortex states in the thin film of two-gap superconductors, in which two kinds of fractional vortices exist because of the presence of two different superconducting order parameters. The most famous example of the two-gap superconductor is MgB2. We discuss the deconfinement mechanism of these fractional vortices, each of which has a continuously valuable fraction of the unit flux quanta via the temperature and/or the magnetic field. We also argue the influence of two fractional vortices to the vortex pinning. The aim is to explain the anomalous "double-peak effect" observed in the field dependence of the pinning force in the vortex state of PrOs4Sb12, which is a strong candidates of the two-gap superconductor. <br

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PS-37: **Nagai, Yuki**

- Affiliation: Department of Physics, University of Tokyo and Condensed-Matter-Theory Lab., RIKEN, Japan
- Title: **"Field Angle Dependence of the Zero Energy Density of States in Unconventional Superconductors"**
- Abstract:

  We calculate the field angle dependence of the density of the states in the low magnetic fields at the zero energy region on the basis of the Kramer-Pesch approximation. One of the tools of the investigation about the superconducting order parameter symmetry is the angular resolved heat capasity experiment. In the low energy and the low magnetic field region, one usually uses the Doppler shift method to analyse the results of the anguler resolved heat capacity experiment. On the basis of the Doppler shift method, the angular dependence of the heat capasity has the cusp structure when the superconductor has the nodes. On the other hand, the results of the numerical calculations suggest that the angular dependence of the heat capasity has the broad minima in the superconductor with the nodes. We show that the Doppler shift method is appropriate in the only case of the two dimensional cylindrical Fermi surface and that the Kramer-Pesch approximation is appropriate and reasonable to analyze the results of the angular resolved heat capasity experiments

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