物性研究所セミナー

標題：非線形セミナー・理論インフォーマルセミナー：Vortex loops in hexagonal rare earth manganites $RMnO_3$ and the Kibble-Zurek mechanism

日時：2014 年 10 月 2 日(木)　午後 3 時～午後 4 時

場所：物性研究所本館 6 階 第 5 セミナー室（A615）

講師：紙屋 佳知

所属：iTHES Research Group and Condensed Matter Theory Laboratory, RIKEN

要旨：

As Onsager and Feynman envisioned, the superfluid to normal transition in Helium-4 can be understood as a proliferation of U(1) vortex loops. We show that the proliferation of Z6 vortex loops that has been recently observed in $RMnO_3$ (R = rare earth ions) compounds at the ferroelectric critical point is a direct manifestation of this phenomenon in systems that have lower Z6 symmetry but the U(1) continuous symmetry emerges at the critical point. Direct imaging of the vortex network in RMnO3 compounds offers unique experimental access to the dual description of the ferroelectric transition, while enabling tests of the Kibble-Zurek mechanism.

標題：LASOR セミナー：Non-equilibrium electronic structure of transient, laser-excited states in Bi-2212

日時：2014 年 10 月 3 日(金)　午後 4 時～

場所：物性研究所本館 6 階 大講義室(A632)

講師：Prof. U. Bovensiepen

所属：University Duisburg-Essen

要旨：

Optical excitations in solid materials typically decay on femto- to picosecond time scales due to elementary interactions which lead to a redistribution of the excess energy among the electronic, the lattice, and the spin subsystem, before final dissipation. In femtosecond time-resolved experiments ultrafast dynamical changes are analyzed in order to shed light on the nature and the dynamics of the superconducting state in high-Tc materials. Femtosecond optical and THz spectroscopy are powerful methods here [1-3]. Recently a transient dynamic coherence was reported far above Tc [4]. Femtosecond time and angle-resolved photoemission spectroscopy (tr-ARPES) [5] probes the electronic structure directly in the presence of optical excitations and opens new opportunities to investigate the influence of collective excitations on the single particle spectral function. Tr-ARPES has been employed to analyze the response of the electronic structure to optical excitations in optimally doped Bi-2212 below Tc [6,7]. In this talk, we discuss the transient electronic structure above Tc at 100 K. We analyze an increased electronic mass and quantify an effective hole photo-doping [8]. We further discuss changes of the relaxation times in the vicinity of the 70 meV kink energy above the Fermi energy originating from to coupling to a Boson mode and recent results obtained for underdoped Bi-2212.

詳細ページ：要旨

http://www.issp.u-tokyo.ac.jp/issp_wms/DATA/OPTION/abstract20141003.doc

標題：中性子セミナー：Neutron Scattering in High Magnetic Fields: tools of today and tomorrow
日時：2014 年 10 月 6 日(月)　午後 1 時 30 分～
場所：物性研究所本館 6 階 第 4 セミナー室（A614）
講師：Dr. Oleksandr Prokhnenko
所属：Helmholtz-Zentrum Berlin (HZB)
要旨：

The Helmholtz-Zentrum Berlin (HZB), Germany, operates two large scale research facilities: the medium flux research reactor BER II and the third generation synchrotron source BESSY II. Wide range of instruments and sample environment, especially in field of sciences at extreme conditions, is available at both facilities for external and internal researchers. Holding a world record of 17.4 T steady state field available for neutron experiments, an ambitious project of extending this range significantly beyond 25 T is close to completion. In this talk I will make an overview of the project and present its main components: The High Field Magnet (HFM), the most powerful DC magnet for neutron scattering in the world, and its neutron counterpart the Extreme Environment Diffractometer (EXED).

Built in collaboration with National High Magnetic Field Laboratory in Tallahassee (USA), the HFM is a horizontal field magnet based on Series Connected Hybrid System Technology. With help of resistive insert coils, which are mounted in the room temperature bore of a superconducting solenoid, fields above 30 Tesla can be obtained. The magnet operation requires complex technical infrastructure which comprises the 20 kA power supply, the water cooling system for the resistive coil and the 4 K Helium refrigerator for cooling the superconducting coil. Because of the infrastructure as well as the magnet dimensions, the HFM cannot be transferred among different instruments like standard split-pair or horizontal superconducting magnets do. As a result, it will be permanently mounted on the dedicated EXED instrument.

A special feature of the HFM is 30° conical openings at both ends of the resistive insert envisaged for neutron scattering access. Covering sufficient Q -range in such a restricted geometry requires a special approach in the neutron instrument design. EXED makes use of polychromatic (time-of-flight) technique enabling to compensate the limited angular access by the extended wavelength range. Combined with 15° magnet rotation, it enables gapless coverage of Q-range from about 0.1 up to 12 $Å^{-1}$ for diffraction experiments. Due to the variable time resolution (from a few μs to the ms-range) and the width of wavelength band (0.6-14.5 Å), the primary instrument becomes very flexible and adjustable to a particular problem.

Based on the science case, the instrument capabilities have been further expanding to include a pin-hole TOF SANS and a direct TOF Spectroscopy (under development). The former extends the low-Q range beyond 10^{-2} $Å^{-1}$. The latter will enable inelastic neutron scattering experiments over a limited Q-range < 1.8 $Å^{-1}$ with an energy resolution of a few percent and E_i < 25 meV.

By the end of this year HFM and EXED will merge together to form a dedicated high field facility for neutron scattering which will be open for users from 2015 on.

標題：理論インフォーマルセミナー：Negative Coulomb drag in coupled quantum wires
日時：2014 年 10 月 9 日(木)　午前 11 時～午後 0 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Dr. Shunsuke Furuya
所属：DPMC-MaNEP, University of Geneva, Switzerland
要旨：

When two parallel quantum wires are coupled only capacitively, an electric current in a wire can drive a current in the other wire purely out of the Coulomb interaction between the wires. This phenomenon is known as Coulomb drag. Recent experimental works [1,2] minutely investigated Coulomb drag and found a negative drag phenomenon in which the drag current flows anti-parallel to the drive one. The observation of the negative drag was "unexpected" [1] because of the absence of theory explaining the negative drag. To the best of our knowledge, existing theories predict only the positive drag. In Ref. [1], the Wigner crystallization in the drag wire was deemed responsible for the negative drag. However Ref. [2] later showed that the negative drag also occurs when the Wigner crystal is not formed. The origin of the negative drag is yet to be fully understood. In this talk, we will propose a simple mechanism to allow for the negative drag based on a theory of the Tomonaga-Luttinger liquid with the long-range Coulomb interaction. We will discuss that the long-range nature of the Coulomb interaction plays the key role in realizing the negative drag.

[1] M. Yamamoto, *et al.*, Science 313, 204 (2006); 山本倫久他，固体物理 41, 679 (2006).
[2] D. Laroche, *et al.*, Nature nanotech. 6, 793 (2011); D. Laroche *et al.*, Science 343, 631 (2014).
[3] S. C. Furuya, H. Matsuura and M. Ogata, in preparation.

標題：理論インフォーマルセミナー：Topological states out of equilibrium
日時：2014 年 10 月 10 日(金)　午前 11 時～午後 0 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Mr. Evert van Nieuwenburg
所属：ETH Zurich
要旨：

In this talk I will consider what happens to one of the simplest 1D symmetry protected topological phases when one switches on a coupling to an environment. For this specific case, we find that the topological nature of this state always gets lost after a certain period of time. I will partially discuss the numerical method we have used (a version of an iTEBD code that can be used for simulating a Lindblad type master equation), and propose a method for a classification scheme for topology in mixed states.

標題：シリーズセミナー　極限コヒーレント光科学 26 回目「Ultrafast time-resolved magneto-optical imaging of coherent spin-waves in a garnet film」
日時：2014 年 10 月 14 日(火)　午後 2 時～
場所：物性研究所本館 6 階 第 1 会議室（A636）
講師：橋本 佑介
所属：ラドバウド大学
要旨：

As a powerful tool for monitoring spatio-temporal resolved spin dynamics, we have developed a new ultrafast time-resolved magneto-optical (MO) microscope with 100 femtosecond time resolution, sub-micrometer spatial resolution, and millidegree accuracy for the light polarization angle [1]. Our system relies on the rotation analyzer method to determine the light polarization angle, which represents the magnetization orientation through MO effects, and a low-noise CCD camera with millions of pixels to obtain the MO images. The main difference of the new system with conventional methods using scanning is the speed of the experiments. Our system gets one MO image in 15 seconds, which is thousands times faster than the conventional technique. By using our new system, we here demonstrate the propagation dynamics of the optically excited coherent spin-waves in a bismuth-doped Garnet film.

標題：理論セミナー：Propulsion of a domain wall in an antiferromagnet by magnons
日時：2014 年 10 月 17 日(金)　午後 4 時～午後 5 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Prof. Oleg Tchernyshyov
所属：Johns Hopkins University
要旨：

Domain walls in magnetic nanowires can be used to store information and perform logical operations.

Whereas the mechanism of domain wall propulsion in ferromagnet (by an applied field, spin-polarized current, or a flux of magnons) are well understood, much less is known about the antiferromagnetic domain walls.

We analyze the dynamics of a domain wall in an easy-axis antiferromagnet driven by a current of circularly polarized magnons.

Magnons pass through a stationary domain wall without reflection and thus exert no force on it. However, they reverse their spin upon transmission, thereby transferring two quanta of angular momentum to the domain wall and causing it to precess. A precessing domain wall partially reflects magnons back to the source. The reflection of spin waves creates a previously identified reactive force. We point out a second mechanism of propulsion, which we term redshift: magnons passing through a precessing domain wall lower their frequency by twice the angular velocity of the domain wall; the concomitant reduction of magnons' linear momentum indicates momentum transfer to the domain wall. We solve the equations of motion for spin waves in the background of a uniformly precessing domain wall with the aid of supersymmetric quantum mechanics and compute the net force and torque applied by magnons to the domain wall. Redshift is the dominant mechanism of propulsion at low spin-wave intensities; reflection dominates at higher intensities. We derive a set of coupled algebraic equations to determine the linear velocity and angular frequency of the domain wall in a steady state.

標題：理論インフォーマルセミナー: Triplon Hall effect in the Shastry Sutherland material
日時：2014 年 10 月 30 日(木)　午後 2 時～
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Prof. Karlo Penc
所属：MTA SzFKI (Hungarian Academy of Sciences)
要旨：

$SrCu_2(BO_3)_2$ is the archetypal quantum magnet with a gapped dimer-singlet ground state and triplon excitations. It serves as an excellent realization of the Shastry Sutherland model, up to small anisotropies arising from Dzyaloshinskii Moriya (DM) interactions. We demonstrate that the DM couplings in fact give rise to topological character in the triplon band structure. The triplons form a new kind of a Dirac cone with three bands touching at a single point, a spin-1 generalization of graphene. An applied magnetic field opens band gaps leaving us with topological bands with Chern numbers *pm* 2. $SrCu_2(BO_3)_2$ is thus a magnetic analogue of the integer quantum Hall effect and supports topologically protected edge modes. At a critical value of the magnetic field set by the strength of DM interactions, the three triplon bands touch once again in a spin-1 Dirac cone, and lose their topological character. We predict a strong thermal Hall signature in the topological regime.

標題：理論セミナー：Theoretical and Experimental Exploration of Two-Dimensional Silicon Structures
日時：2014 年 10 月 31 日(金)　午後 4 時～午後 5 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：尾崎 泰助
所属：東京大学物性研究所計算物質科学研究センター
要旨：

Although it is believed that two-dimensional honeycomb structures consisting of silicon atoms do not exist experimentally due to relative instability of its hybridized sp2 orbitals, a recent experiment clearly demonstrates that silicene, honeycomb structure of silicon atoms, can be fabricated on ZrB2 (0001) thin films [1]. Here, we report on detailed studies for geometrical and electronic structures of silicene on ZrB2 and a related two-dimensional structure by means of electronic structure calculations based on density functional theories (DFT), guided by a close collaboration with experiments performed by the Yamada-Takamura group of JAIST [1-6]. Theoretical chemical shift of Si-2p states [1] and band structure calculations [4] strongly support the formation of silicene having a planar-like structure. The stability of the planar-like structure over the regularly buckled structure can be understood by interaction between states of the silicene and surface states consisting of the d-orbital of the top Zr atoms [2]. We also propose a possible mechanism for the formation of the domain structure of silicene on ZrB2 [1,5]. It is inferred that the domain structure is induced by an instability of a phonon having a nearly zero frequency, and is formed in such a way that the k-points having the zero frequency can be removed from the first Brillouin zone. The mechanism is verified by performing large-scale total energy calculations. We further explore a possible structure of multi-layer silicene, and find that the MoS2 structure consisting of silicon atoms is stabilized with atoms in the inner layer having a sixfold coordination, which results in cigar-shaped nematic orbitals originating from the Si-sp2 orbitals [6].

[1] A. Fleurence, R. Friedlein, T. Ozaki, H. Kawai, Y. Wang, and Y. Yamada-Takamura, Phys. Rev. Lett. 108, 245501 (2012).
[2] C.-C. Lee, A. Fleurence, R. Friedlein, Y. Yamada-Takamura, and T. Ozaki, Phys. Rev. B 88, 165404 (2013).

[3] A. Fleurence, Y. Yoshida, C.-C. Lee, T. Ozaki, Y. Yamada-Takamura, and Y. Hasegawa, Appl. Phys. Lett. 104, 021605 (2014).
[4] C.-C. Lee, A. Fleurence, Y. Yamada-Takamura, T. Ozaki, and R. Friedlein, Phys. Rev. B 90, 075422 (2014).
[5] C.-C. Lee, A. Fleurence, R. Friedlein, Y. Yamada-Takamura, and T. Ozaki, submitted to Phys. Rev. Lett.; arXiv:1408.2588.
[6] F. Gimbert, C.-C. Lee, R. Friedlein, A. Fleurence, Y. Yamada-Takamura, and T. Ozaki, Phys. Rev. B, in press; arXiv:1401.0142.

標題：理論インフォーマルセミナー：Topologically Protected Dynamics of Dzyaloshinskii-Moriya Spin Textures
日時：2014 年 10 月 31 日(金)　午後 1 時 30 分～午後 2 時 30 分
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Oleg Tretiakov
所属：東北大学　金属材料研究所
要旨：

Ferromagnetic (FM) and antiferromagnetic (AFM) structures can be employed to store and manipulate information by means of topological spin textures, such as skyrmions, vortices, or domain walls. We study current and field driven spin-texture dynamics in thin FM and AFM nanostructures. We derive effective equations of motion describing the dynamics of a spin-texture soft modes associated with its topological defects. Because these spin textures are topological objects, the equations are rather universal and depend only on a few parameters.

This method allows us to include in FMs such effects as Dzyaloshinskii-Moriya interaction (DMI) and breaking of translational invariance for nonuniform nanowires. Furthermore, we argue that the combined effects of space curvature and spin-orbit induced DMI can lead to even more exciting possibilities for domain wall propagation.

For example, we show that domain walls are more robust to perturbations in ferromagnetic nanotubes with DMI and can be manipulated differently depending on their orientation and chirality.

標題：表面セミナー「Real-Time Studies of Atomic Layer Deposition and Chemical Vapour Deposition by Ambient Pressure X-Ray Photoelectron Spectroscopy」
日時：2014 年 10 月 31 日(金)　午後 5 時～午後 6 時
場所：物性研究所本館 6 階 第 4 セミナー室（A614）
講師：Joachim Schnadt　**教授**
所属：ルント大学
要旨：

Atomic layer deposition (ALD) and the closely related Chemical vapour deposition (CVD) are two of the most important methods to achieve a controlled growth of thin films on surfaces. Relatively little is known, however, about which molecular and surface species play a role during the growth and how chemical kinetics affect the growth process and quality of films. One of the reasons is that few real-time studies have been performed which can identify such species. We aim at addressing this lack and clarify the type and role of surface species during thin film growth using ambient pressure x-ray photoelectron spectroscopy (APXPS). Recent efforts were targeted towards the ALD of TiO2 from different precursors as well as the CVD of SiO_2.

Further, I will give a brief overview of the status of the new MAX IV synchrotron light source and briefly present the APXPS beamlines SPECIES and HIPPIE.

標題：新物質セミナー：Mutli redox processes and electronic interactions in Metal- Tetrathiafulvalene complexes

日時：2014 年 10 月 31 日(金)　午前 11 時～午後 0 時

場所：物性研究所本館 6 階 第 5 セミナー室（A615）

講師：Prof. Dominique Lorcy

所属：Institut des Sciences Chimiques de Rennes, UMRCNRS 6226 University of Rennes 1, France

要旨：

Tetrathiafulvalenes (TTFs) and other electro-active analogues have been extensively studied in the search for molecular conductors and superconductors.1 These properties are ascribed to the presence of mixed valence species. The formation of such species is not easy to control unless two electro-active units interact either through space or through bond in a dimeric structure. Accordingly, a range of TTF dimers linked by various organic linkers have been synthesized.2 The interplay between two redox active TTF generates a multistage redox behaviour affected by the type of linker. Most of the interactions detected through the organic linkers are weak and in order to increase these interactions the elaboration of transition metal complexes containing two TTF ligands has been developed.3 In this context we recently investigated the synthesis and the influence of redox active ligands such as TTF acetylacetonate,4 TTF acetylide5 and TTF dithiolate, that will be presented during the lecture.

標題：新量子相 Lecture Series　**第 6 回：**「Interacting Electrons on the Pyrochlore Lattice」

日時：2014 年 11 月 13 日(木)　午前 10 時～午後 0 時

場所：物性研究所本館 6 階 第 5 セミナー室（A615）

講師：Collin Broholm

所属：The Johns Hopkins University

要旨：

The corner-sharing simplex nature of the pyrochlore lattice underlies a rich variety of correlated electron physics. In the insulating semi-classical limit, materials such as $Dy_2Ti_2O_7$ and $Ho2Ti_2O_7$ form magnetic analogues of water ice with Pauling entropy and emergent magnetic monopoles. Quantum fluctuations may melt spin ice and in pursuit of the putative spin liquid, experiments on materials such as $Pr2Zr_2O_7$ and $Yb2Ti_2O_7$ have encountered dynamic magnetism and extreme sensitivity to subtle sample characteristics. Simplex physics also underlies the cooperative paramagnetism of chromium spinels, with dynamics cluster correlations, and spin-Peierls-like magneto-structural transitions. Adding mobile fermions in LiV_2O_4 and $Pr_2Ir_2O_7$ yields heavy fermion physics and anomalous transport linked to non-collinear spin correlations. The talk provides an overview of an active field of research with ample opportunities for discoveries of fundamental and technological significance.

標題：放射光セミナー：梯子型鉄系化合物 AFe_2X_3(A=Ba,Cs; X=S,Se,Te)の電子物性
日時：2014 年 11 月 20 日(木)　午前 10 時 30 分～
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：平田 靖透
所属：物性研究所　軌道放射物性研究施設　和達研究室
要旨：

鉄カルコゲナイド化合物 AFe_2X_3(A=Ba,Cs; X=S,Se,Te)は鉄系超伝導体の類縁物質であり、鉄原子が梯子構造をなす反強磁性体でる。鉄系超伝導体の母物質が二次元的な電子状態を持ち金属的伝導を示すのにし、AFe_2X_3 はその擬一次元的構造を反映して常圧では絶縁体である。しかし同様に梯子構造を持つ銅酸化物 $Sr_{14-x}Ca_xCu_{24}O_{41}$ では加圧により超伝導が発現する[1]ことから、我々はこれまで AFe_2X_3 に対する超伝導探索および物性測定を行ってきた。その結果、$BaFe_2Se_3$ はブロック型、$CsFe_2Se_3$ や $BaFe_2S_3$ はそれぞれモーメントの向きが異なるストライプ型といった、多種多様な反強磁性秩序をとること、$CsFe_2Se_3$ は電荷秩序のない混合原子価化合物であるにも関わらず絶縁性が強いことなど、この系が独特の物性を持つことを明らかにしてきた[2-4]。また最近では $BaFe_2S_3$ が 10GPa 付近の高圧下で圧力誘起金属絶縁体転移を起こして金属化することが確認されており、その電子状態の鉄系超伝導体との関係に関心が持たれる[5]。本セミナーでは、$BaFe_2S_3$ の高圧下赤外分光による圧力誘起金属絶縁体転移のメカニズム解明を中心に、主に放射光を用いた AFe_2X_3 の物性研究の成果を紹介し、擬一次元的な鉄系化合物における特異な電子物性の起源を考察する。

参考文献：

[1] M. Uehara *et al.*, J. Phys. Soc. Jpn. 65, 2764 (1996).
[2] Y. Nambu *et al.*, Phys. Rev. B 85, 064413 (2012).
[3] F. Du *et al.*, Phys. Rev. B 85, 214436 (2012).
[4] F. Du, Y. Hirata *et al.*, Phys. Rev. B 90, 085143 (2014).
[5] 杉本旭ほか、日本物理学会 2013 年秋季大会 26aPS-104 (2013).

標題：新量子相 Lecture Series 第 7 回:「Symmetry protected topological order and cohomology theory」
日時：2014 年 11 月 21 日(金)　午後 1 時～午後 3 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Prof. Xiao-Gang Wen
所属：Perimeter Institute and MIT
要旨：

Symmetry protected topological (SPT) states are a new kind of gapped states that do not break any symmetry and have no topological order. Despite having no symmetry breaking order and having no fractionalized topological excitations, SPT states can still be non-trivial. I will present,

(1) a systematic theory of SPT order based on non-linear sigma model and its topological terms,
(2) ways to probe/measure SPT orders, and the connection to anomalies,
(3) mechanism to generate SPT orders.

標題：理論セミナー：Computational Modeling of Active Matter: Collective Dynamics in Swimming Suspension
日時：2014 年 11 月 21 日(金)　午後 4 時～午後 5 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：John J. Molina
所属：京都大学大学院工学研究科化学工学専攻
要旨：

Active or living systems, defined by their ability to continuously extract local energy from the medium and convert it into mechanical work (constituting a non-equilibrium system), have attracted immense attention in recent years. The reason is simple, these systems are found everywhere in nature and are fundamental to all biological processes. Examples include bacteria and spermatozoa, as well as newly created nano-motors. Active matter systems have been shown to exhibit physical properties that are completely different from their (equilibrium) non-active counterparts. These phenomena include anomalous diffusion and viscosity, collective motion, giant number fluctuations, and self-sustained turbulence, among many others. While we have a basic understanding of the specific propulsion mechanism (i.e., how they swim), our knowledge of their collective behavior is still very poor. One of the main problems, is the difficulty of properly treating the hydrodynamic interactions among the particles.

The goal of our work is to understand the influence of the swimming motion on the collective properties of swimming suspensions. For this, it is necessary to use a detailed model that includes the many body hydrodynamic interactions among the particles. We have implemented a simple (spherical) swimmer model using the Smooth Profile Method (SPM), which accurately resolves both the fluid and particle motion, and which is capable of treating both pushers and pullers (swimmers with the propulsion mechanism at the back and front, respectively). Using this direct numerical simulation method, we have studied the interplay between hydrodynamic and particle interactions, which gives rise to two very different time and length scales. We consider how these two regimes affect the collective motion of suspensions in bulk 3D solutions, as well as in the confined 2D geometries common in experimental setups.

標題：新物質セミナー：Ferromagnetic quantum criticality in $YbNi_4P_2$
日時：2014 年 12 月 3 日(水)　午前 11 時～午後 0 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Prof. Cornelius Krellner
所属：Goethe-University Frankfurt/Main, Germany
要旨：

Quantum critical phenomena fascinate solid-state physicists for quite some time now, as emerging phases of matter can be observed in the vicinity of quantum critical points (QCPs).

Pressure, magnetic field, or chemical substitution are the common parameters to drive a material from one ground state to another and to explore the phase diagram. How a ferromagnetic (FM) state disappears has long been the subject of intense research. There is presently strong evidence that in most materials a quantum phase transition is prevented by the coupling of the FM order parameter to particle hole soft modes, which induces a first order transition or other types of magnetic order before the Curie temperature, TC, reaches T=0. Therefore, the recent observation of FM quantum criticality in the new heavy-fermion material $YbNi_4P_2$ substituted with As was remarkable [1].

In this presentation, I review the crystal growth and the thermodynamic characterization of $YbNi_4P_2$ which is a stoichiopmetric FM-Kondo lattice with a severely reduced Curie temperature (TC=0.17 K) due to strong Kondo screening (TK~8 K) already very close to the FM QCP [2]. The crystal structure of $YbNi_4P_2$ is novel among heavy-fermion systems with quasi-one-dimensional Yb-chains along the c-axis of the tetragonal unit cell. Substituting larger As for P tunes the system towards the FM quantum critical point. The FM transition stays second order and ferromagnetic down to TC=30 mK, which is the lowest ferromagnetic transition temperature ever observed. The unexpected power-law exponents in all thermodynamic quantities indicate the presence of strong FM quantum critical fluctuations and require new theoretical concepts to describe this FM QCP.

Work in collaboration with M. Brando, C. Geibel, K. Kliemt, R. Küchler, S. Lausberg, M. Nicklas, H. Pfau, F. Steglich, A. Steppke

[1] A. Steppke *et al.*, Science 339, 933 (2013).
[2] C. Krellner *et al.*, New J. Phys. 13, 103014 (2011).

標題：理論セミナー：Realizing symmetry-protected topological phases with ultra-cold SU(N) fermions
日時：2014 年 12 月 5 日(金)　午後 4 時～午後 5 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：戸塚 圭介
所属：京都大学 基礎物理学研究所
要旨：

There are a variety of states of matter called “topological”, that defy the traditional Landau-type description based on local order parameters. Prototypical examples are fractional quantum Hall states and quantum spin liquids which are characterized by long-range entanglement and are known to host fractionalized exotic quasi-particles. The discovery of topological insulators/superconductors sparked the study of another species of topological phases, now dubbed “symmetry-protected topological (SPT)”, which is stable only in the presence of certain symmetries (e.g., time-reversal, reflection, space groups, etc.) [1,2].

In this talk, I show how various SPT phases appear in SU(N)-symmetric ultra-cold fermions [3] loaded in one-dimensional optical lattice and characterize these phases by using entanglement spectrum [4]. An interesting connection between entanglement spectrum and non-local order parameters will be discussed, too.

[1] X-L. Qi and S-C. Zhang, Rev.Mod.Phys. 83, 1057 (2011).
[2] F. Pollmann *et al.*, Phys.Rev.B 81, 064439 (2010); Z. Gu *et al.*, ibid, 83, 035107 (2011); A. Vishwanath and T.Senthil, Phys.Rev.X 3, 011016 (2013).
[3] A.V. Gorshkov *et al.*, Nat.Phys. 6, 289 (2010); S. Taie *et al.*, ibid., 8, 825 (2012).
[4] H. Nonne *et al.*, Europhys.Lett. 102, 37008 (2013); V. Bois *et al.*, arXiv:1410.2974

標題：放射光セミナー：トポタクティック合成法による酸化物薄膜へのアニオンドープ

日時：2015 年 1 月 13 日(火)　午後 1 時 30 分～

場所：物性研究所本館 6 階 第 1 会議室（A636）

講師：近松　彰

所属：東京大学大学院　理学系研究科　化学専攻　固体化学研究室

要旨：

銅酸化物の高温超伝導やマンガン酸化物の超巨大磁気抵抗に代表されるように、強相関電子系酸化物は元素をドープすることで物性が著しく変化する。その方法の中には、イオン半径の異なる元素をドープし化学圧力効果を変える方法や、価数の異なる元素をドープしキャリアを注入する方法があり、多くの研究が行われている。ところがこれらの研究はカチオンドープが圧倒的に多く、アニオン（水素、窒素やフッ素）ドープの例は少ない。これは、カチオンドープが固相合成で容易に出来るのに対して、アニオンドープは高温・高圧が必要であったり、有毒で扱いにくいアンモニアガスやフッ素ガスを必要とするなど技術的な困難を伴うからである。

上記の問題をクリアした簡便なアニオンドープの方法として、有機合成に使われている反応剤を用いたトポタクティック合成法がある。トポタクティック合成とは、化合物の基本構造を反応前後で保ったまま元素を出入りさせられる合成法である。これまで我々は、酸化物薄膜にトポタクティック合成法を適用することで、様々な遷移金属酸水素化物・酸フッ化物薄膜の合成に成功した[1-6]。薄膜試料は体積が極めて小さいため、トポタクティック反応は表面のみならず試料全体で進行する。すなわち、バルク試料では反応が十分に進行せず合成が困難だった物質も、薄膜試料では合成できる可能性を秘めており、新物性の発現が期待できる。また、バルク体と比較してより低温でアニオンドープが進行したり、エピタキシャル応力を掛けられたりという薄膜ならではの特長も加えられる。本講演では、これまで行ったトポタクティック合成法による酸化物薄膜へのアニオンドープの結果を紹介し、見出した新物質に対する放射光を用いた研究展開について議論する。

[1] T. Katayama, A. Chikamatsu, *et al.*, J. Phys. D: Appl. Phys. 47, 135304 (2014).

[2] T. Katayama, A. Chikamatsu, *et al.*, J. Mater. Chem. C 2, 5350 (2014).

[3] T. Katayama, A. Chikamatsu, *et al.*, J. Sol-Gel Sci. Tech. in press. DOI:10.1007/s10971-014-3499-x

[4] 片山司、近松彰ほか、第 75 回応用物理学会秋季学術講演会、17p-A10-3　(2014).

[5] 小野塚智也，近松彰ほか、第 75 回応用物理学会秋季学術講演会、18p-A11-11(2014).

[6] 河原佳祐，近松彰ほか、第 75 回応用物理学会秋季学術講演会、18a-A11-7(2014).