物性研究所セミナー

標題：理論インフォーマルセミナー：Spin-orbital frustration in pyrochlores $A_2Mo_2O_7$
日時：2013 年 10 月 2 日(水)　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：品岡　寛
所属：ETH - Institute for Theoretical Physics
要旨：

Molybdenum pyrochlores $A_2Mo_2O_7$ have been investigated extensively because of their fascinating electronic and magnetic properties [1]. In particular, insulating compounds (A=Y, Tb, etc.) exhibit spin-glass behavior instead of conventional long-range ordering. However, the origin of the peculiar magnetic properties still remains to be clarified.

We study a typical insulating compound $Y_2Mo_2O_7$ by the fully relativistic density-functional theory plus on-site repulsion (U) method [2]. We find peculiar competition in energy between different magnetic states in the large-U insulating region, which cannot be explained by simple Heisenberg antiferromagnetic models adopted in previous studies. We reveal that the system is in the competing region where anisotropic antiferromagnetic and ferromagnetic exchange interactions are competing with each other.

Analyzing a three-orbital Hubbard model, we clarify that the magnetic competition is tightly connected with orbital frustration in the $4d^2$ electronic configuration through the spin-orbital interplay. The results challenge the conventional picture of the spin-glass behavior that attributes the origin to the geometrical frustration of purely antiferromagnetic exchange interactions.

[1] J. S. Gardner, M. J. P. Gingras, and J. E. Greedan, Rev. Mod. Phys. **82**, 53 (2010).
[2] H. Shinaoka, Y. Motome, T. Miyake, and S. Ishibashi, arXiv:1305. 0660.

標題：理論インフォーマルセミナー：物性研理論系研究室 2013 年度秋期学会発表講演会
日時：2013 年 10 月 4 日(金)　後 1 時 30 分～午後 5 時
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
要旨：

13:30－13:45　阪野 塁（加藤研 助教）
「S=1 近藤ドットのスピン・軌道チャンネル電流間相関とエンタングルメント」

13:45－14:00　正木 晶子（川島研 研究員）
「ワーム更新による並列化量子モンテカルロアルゴリズム」

14:00 － 14:15　高田 えみか（押川研 M2）
「S=3/2 パイロクロア反強磁性体の飽和磁化近傍量子相の理論的研究」

14:15－14:30　渡辺 宙志（川島研 助教）
「レプリカ交換モンテカルロ法を用いた数独の問題作成」

14:30－14:45　休憩

14:45－15:00　植村 渉（杉野研 D3）
「対称テンソル分解による多電子系の電子状態の研究」

15:00－15:15　藤 陽平（押川研 D2）
「フラストレートした 4 本鎖スピンラダーにおけるカイラリティ液体」

15:15－15:30　鈴木 貴文（加藤研 M2）
「振動外場下での量子ドットの動的輸送特性に与えるバーテックス補正の効果」

15:30－15:45　Wenxing NIE（押川研 D3）
“Intrinsic Angular Momentum and Edge Current of Chiral Superfluids in 2D Infinite Circular Well”

15:45－16:00　休憩

16:00－16:15　野口 良史（杉野研 助教）
「M+@C60 (M=H, Li, Na, K)の安定性と光学特性に関する第一原理計算」

16:15－16:30　毛利 宗一朗（押川研 M2）
「J1-J3-J4 モデルの量子相転移のユニバーサリティークラス」

16:30－16:45　堀田 俊樹（藤堂研 M2）
「長距離相互作用のあるイジング模型の相関長とユニバーサリティクラス」

16:45－17:00　芝 隼人（野口研 助教）
「過冷却液体における局所密度の不均一性と動的不均一、基準振動モード」

標題：理論インフォーマルセミナー：Flattening the bands of the Hofstadter Butterfly
日時：2013 年 10 月 9 日(水) 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：Dr. Gunnar Möller
所属：Cavendish Laboratory, Cambridge, UK
要旨：

Over the last two years, there has been tremendous interest in "fractional Chern insulators", incompressible phases in topologically non-trivial bands with finite Chern number. We provide a formal proof that the phases of interacting particles in topological flat bands with Chern number C = 1 can be adiabatically connected to fractional quantum Hall liquids. Our approach, based on hybrid Wannier orbitals, enables a formal proof of the equality of their respective topological orders [1]. Furthermore, this proof robustly extends to the thermodynamic limit.

The fractal spectrum of a charged particle on a lattice pierced by a homogenous flux density provides bands of any Chern number. We review the understanding of strongly correlated phases occurring when the C > 1 bands of the Hofstadter spectrum are filled by bosons with repulsive interactions, including composite fermion states at general flux densities [2] and variants of Halperin states found near rational flux densities. Here, we analyse the nature of these phases in the language of fractional Chern insulators, asking in particular to which extent the problem of interacting bosons in the Hofstadter bands is represented faithfully by the projection to the flattened lowest energy band [3].

[1] T. Scaffidi and G. Möller, Phys. Rev. Lett. 109, 246805 (2012).
[2] G. Möller and N. R. Cooper, Phys. Rev. Lett. 103, 105303 (2009).
[3] G. Möller and N. R. Cooper, to be published.

標題：理論インフォーマルセミナー

日時：2013 年 10 月 30 日(水)　午後 3 時～午後 5 時

場所：物性研究所本館 6 階 第 5 セミナー室（A615）

要旨：15：00－15：45

講師：Jérôme Rech

所属：Centre de Physique Théorique, Aix Marseille Université

題目：Interactions and charge fractionalization in an electronic Hong-Ou-Mandel interferometer

要旨：

We consider an electronic analog of the Hong-Ou-Mandel (HOM) interferometer, where two single electrons travel along opposite chiral edge states and collide at a quantum point contact. Studying the current noise, we show that because of interactions between co-propagating edge states, the degree of indistinguishability between the two electron wavepackets is dramatically reduced, leading to reduced contrast for the HOM signal. This decoherence phenomenon strongly depends on the energy resolution of the packets. Insofar as interactions cause charge fractionalization, we show that charge and neutral modes interfere with each other, leading to satellite dips or peaks in the current noise. Our calculations explain recent experimental results [1] where an electronic HOM signal with reduced contrast was observed.

[1] E. Bocquillon, *et. al.,* Science **339**, 1054 (2013).

16：00－16：45

講師：Thierry Martin

所属：Centre de Physique Théorique, Aix Marseille Université

題目：Multipair DC-Josephson resonances in a biased all-superconducting bijunction

要旨：

An all-superconducting bijunction consists of a central superconductor contacted to two lateral superconductors, such that non-local crossed Andreev reflection is operating. Then new correlated transport channels for the Cooper pairs appear in addition to those of separated conventional Josephson junctions. We study this system in a configuration where the superconductors are connected through gate-controllable quantum dots [2]. Multipair phase-coherent resonances and phase-dependent multiple Andreev reflections are both obtained when the voltages of the lateral superconductors are commensurate, and they add to the usual local dissipative transport due to quasiparticles. The two-pair resonance (quartets) as well as some other higher order multipair resonances are p -shifted at low voltage. Dot control can be used to dramatically enhance the multipair current when the voltages are resonant with the dot levels.

[2] T. Jonckheere *et. al.,* Phys. Rev. B **87**, 214501 (2013).

標題：ナノサイエンスセミナー：Synchrotron X-ray Scanning Tunneling Microscopy

日時：2013 年 11 月 1 日(金)　午前 11 時～午後 0 時

場所：物性研究所本館 6 階 第 1 会議室（A636）

講師：Dr. Volker Rose

所属：Advanced Photon Source & Center for Nanoscale Materials, Argonne National Laboratory

要旨：

The combination of the high spatial resolution of scanning tunneling microscopy with the chemical and magnetic contrast provided by synchrotron X-rays has the potential to allow a unique characterization of advanced materials. [1] While the scanning probe provides the high spatial resolution, synchrotron X-rays that produce photo-excitations of core electrons add chemical and magnetic contrast. The x-ray excitations result in tip currents that are superimposed onto conventional tunneling currents. [2] We have developed an easy-to-implement filter circuit that can separate the x-ray induced currents from conventional tunneling currents, thereby allowing simultaneous measurements of topography and chemical contrasts. [3] Critical for high spatial resolution are insulator-coated "smart tips" with small conducting apex. Such tips drastically reduce the background of photoejected electrons by reducing the detection area to the tip apex.

In this talk, we will discuss the physical principles of synchrotron x-ray scanning tunneling microscopy (SXSTM) as well as the implementation of this emerging technique at the Advanced Photon Source at Argonne National Laboratory. [4]

References

[1] V. Rose, J.W. Freeland, S.K. Streiffer, "New Capabilities at the Interface of X-rays and Scanning Tunneling Microscopy", in Scanning Probe Microscopy of Functional Materials: Nanoscale Imaging and Spectroscopy, S.V. Kalinin, A. Gruverman, (Eds.), Springer, New York (2011), pg 405-432.

[2] Volker Rose, Kangkang Wang, TeYu Chien, Jon Hiller, Daniel Rosenmann, John W. Freeland, Curt Preissner, Saw-Wai Hla, Adv. Funct. Mater. 23, 2646 (2013).

[3] Kangkang Wang, Daniel Rosenmann, Martin Holt, Robert Winarski, Saw-Wai Hla, and Volker Rose, Rev. Sci. Instrum. 84, 063704 (2013).

[4] M.L. Cummings, T.Y. Chien, C. Preissner, V. Madhavan, D. Diesing, M. Bode, J.W.Freeland, and V. Rose, Ultramicroscopy 112, 22 (2012).

標題：ナノサイエンスセミナー：Magnetization dynamics derived from excitations of single magnetic atoms on surfaces

日時：2013 年 11 月 1 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 1 会議室（A636）

講師：Dr. Alexander Ako Khajetoorians

所属：Institute for Applied Physics, Hamburg University, Hamburg, Germany

要旨：

With the development of sub-Kelvin high-magnetic field STM, two complementary methods, namely spin-polarized scanning tunneling spectroscopy (SP-STS) [1] and inelastic STS (ISTS) [2-3], can address single spins at the atomic scale. While SP-STS reads out the projection of the impurity magnetization, ISTS detects the excitations of this magnetization as a function of an external magnetic field. They are thus the analogs of magnetometry and spin resonance measurements pushed to the single atom limit. We have recently demonstrated that it is possible to

reliably combine single atom magnetometry with an atom-by-atom bottom-up fabrication to realize complex atomic-scale magnets with tailored properties [4-5]. In this talk, I will address recent developments in probing the spin excitations and magnetization curves of atoms on a multitude of non-magnetic surfaces, and the effects of the electronic structure on the precessional dynamics of the atomic spin. Moreover, I will discuss investigations of the magnetization dynamics [6] of coupled spins as probed with spin-resolved STM techniques and how the relaxation is affected by processes like quantum tunneling and spin-transfer torque.

[1] A. A. K., *et al.*, PRL, 106, 037205 (2011).
[2] A. J. Heinrich, *et al.*, Science, 306, 466 (2004).
[3] A. A. K, *et al.*,Nature, 467, 1084 (2010).
[4] A. A. K., *et al.*, Nature Physics, 8, 497 (2012).
[5] A. A. K., *et al.*, Science, 332, 1062 (2011).
[6] A. A. K., *et al.*, Science, 339, 55 (2013).

標題：フェムト秒域高次高調波を用いた時間分解角度分解光電子分光
日時：2013 年 11 月 4 日(月)　午後 2 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：Martin Aeschlimann
所属：University of Kaiserslautern
要旨：

Rapid progress in ultrafast X-ray science worldwide, both in high-harmonic and X-ray free electron laser sources, has paved the way for a completely new generation of real time experiments investigating ultrafast processes in all areas of science. Femtosecond and attosecond pulses are now available spanning the extreme ultraviolet and soft X-ray regions of the spectrum that are perfectly synchronized to a pump laser pulse.

After an introduction to high-harmonic generation (HHG) and survey, the impact of using these table-top light-sources for the study of ultrafast material science will be shown. For instance, the laser assisted photoelectric effect (LAPE) could be demonstrated for IR-XUV excitation of a Pt(111) surface [1] as well as laser assisted Auger decay (LAAD) [2]. Recent scientific breakthroughs employing X-ray pulses from HHG in the areas of surface dynamics [3], correlated-electron materials [4], and heterogeneous magnetic materials [5,6,7] will be discussed. The review concludes with a summary and an outlook to the feasibility of real time studies of photo-induced phase transitions in a broad class of advanced correlated materials.

[1] L. Miaja-Avila *et al*, Phys. Rev. Lett. 97, 113604 (2006).
[2] L. Miaja-Avila *et al*, Phys. Rev. Lett. 101, 046101 (2008).
[3] S. Mathias, Journal of Physics: Conference Series 148, 012042 (2009).
[4] T. Rohwer *et al*, Nature 471, 490 (2011).
[5] C. La-O-Vorakiat *et al*, Phys. Rev. Lett. 103, 257402 (2009).
[6] S. Mathias *et al*, PNAS, 109 (13), 4792 (2012).
[7] E. Turgut *et al*, Phys. Rev. Lett. , in press.

標題：理論インフォーマルセミナー：Thermoelectric properties of bad metals
日時：2013 年 11 月 5 日(火)　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：Veljko Zlatić
所属：Institute of Physics, Zagreb, Croatia
要旨：

We discuss the thermoelectric response of bad metals, materials obtained by doping charge carriers into Mott-Hubbard insulators. Typical examples are provided by the vanadates, cobaltates, cuprates and other oxides. Their transport properties show the universal features that can be summarized as follows. (i) At very low doping (lightly doped Mott insulators), the resistivity $\rho(T)$ is exponentially large and has a negative slope. The thermopower $\alpha(T)$ has a large peak that shifts to higher temperatures with doping. (ii) At moderate doping (underdoped oxides), $\rho(T)$ has a positive slope and looks metallic but its magnitude exceeds the Joffe-Regel limit. The peak of $\alpha(T)$ is much reduced and shifted to low temperatures. Above the peak, $\alpha(T)$ changes sign. (iii) At large doping (overdoped oxides), $\rho(T)$ is T^2-like at low temperatures and T -linear at high temperatures. $\alpha(T)$ is negative at all temperature. The crossover from 'doped insulators' to 'underdoped bad metals' and from 'underdoped' to 'overdoped bad metals' occurs at doping levels x_b and x_c, respectively.

The universal thermoelectric response of bad metals is explained by an effective model with large on-site correlation which opens the Mott-Hubbard gap in undoped systems.As a minimal model, we use the Falicov-Kimball model which approximates very well the incoherent phase of the Hubbard model but is easer to solve [1,2]. The transport coefficients are calculated by the dynamical mean field theory and the results exhibit the same features as the experimental data. At very low doping, the model behaves as a 'lightly doped' Mott insulator. At higher doping, we find a bad metal which is either 'underdoped' or 'overdoped'. The crossover, characterized by $\alpha(T) \simeq 0$, occurs at x_c. The Kelvin formula, $\alpha(T)=-(k_B/e)(\partial\mu/\partial T)$, shows that the chemical potential μ assumes at x_c a constant value and the entropy has a maximum. In cuprates, the optimal doping maximizes T_c [3].

References:
[1] V. Zlatić, G. R. Boyd, J. K. Freericks, arXiv:1307. 4800.
[2] V. Zlatić, J. K. Freericks. arXiv:1210.5977. Phys. Rev. Lett., **109**, 266601 (2012).
[3] S. D. Obertelli, J. R. Cooper, and J. L. Tallon, Phys. Rev. B, **46**, 14928 (1992).

標題：中性子・理論合同セミナー：Pd 系合金における水素吸蔵特性に関する理論検討
日時：2013 年 11 月 6 日(水)　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：屋山　巴
所属：九州大学・稲盛フロンティア研究センター, JST-CREST
要旨：

Pd は単体で水素吸蔵能を有する金属として知られている。これに対し、異種元素を Pd に固溶させた合金では水素吸蔵量が変化する例が報告されている。近年では、ナノ粒子化および水素プロセスを経ることにより、元来固溶しない元素間の合金の作製例が報告されており、中には単体 Pd ナノ粒子に比べて水素吸蔵量が向上した例も示されるなど、新規水素吸蔵合金創製への期待が高まっている。本研究では、Pd 系固溶体における水素吸蔵特性への異種元素の寄与を解明するため、密度汎関数法に基づく第一原理計算を用いた検討を行った。$Pd_{1-x}M_x$ (M=Ir, Pt, Au)固溶体モデルを用いて八面体サイトへの水素吸蔵エネルギー、および状態密度を計算した。

計算結果より、水素吸蔵エネルギーの添加元素、および吸蔵サイト位置に対する依存変化が確認された。水素原子は Pd のみで構成されるサイトにおいて安定となり、異種元素を含むサイトではいずれも不安定となった。このことから、Pd 系合金において、異種元素の水素吸蔵そのものへの寄与は小さいが、Pd が本来持つ水素吸蔵特性に影響を与えることにより、合金全体の水素吸蔵量が変化する可能性が示唆された。さらに、合金組成に伴う格子定数変化と状態密度の関係に着目し、水素吸蔵エネルギー変化との関連について議論を行う。

標題：理論セミナー：Frozen states and order-disorder transition in the adhesion of confined membranes
日時：2013 年 11 月 8 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：Olivier PIERRE-LOUIS
所属：CNRS - ILM, Universite Lyon-1
要旨：

Lipid membranes have attracted much attention in the past decades, both for their unique physical properties, and for their wide biological relevance. For example, membranes are the main ingredient of cell walls, and stacks of lipid membranes play an important role as protective coatings in biolubrication systems and in the stratum corneum. Usually these biological systems are crowded, and membranes are confined between other membranes, or between other biological material.

In this talk, we will discuss the role of confinement on the adhesion of lipid membranes by studying the adhesion of a membrane between two flat walls within a hydrodynamic model. We find frozen states with finite-size adhesion patches, and an order-disorder transition controlled by the permeability of the walls. Adding noise to the model, we recover coarsening with exponents controlled by the wall permeability.

標題：ナノサイエンスセミナー：Electronic and Spin States in Metal-Organic Supramolecular Materials at Surfaces probed by Spectro Microscopy Correlation
日時：2013 年 11 月 11 日(月) 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. Thomas A. Jung
所属：Laboratory for Micro- & Nanotechnology, Paul Scherrer Institute
要旨：

Well defined electronic and spintronic interfaces can be architectured by combining self-assembly and surface science. The atomically clean metal surface in the ultra-high vacuum provides a very specific environment affecting the behaviour of the ad-molecules as well as the adsorbent-adsorbate interaction. Depending on the bonding at the interface, complex electronic and magnetic interaction can occur which can be explored using spectro-microscopy correlation, in this case photoemission and photoabsorption spectroscopy (PES, PAS) and Scanning Tunnelling Microscopy (STM).

One example is provided by the emergence of quantum dot states from the interaction of a porous network with the 2D (Shockley) surface state of Cu(111) which exhibit sufficient residual coupling to show the emergence of a band-like structure in angle resolved photoemission experiments [1]. In another example, specifically chosen surface supported molecules have been shown to exhibit ferromagnetic [2] or anti-ferromagnetic [3] exchange interaction and their spin

system has been shown to change induced by physical parameters and / or chemical stimuli [4]. By combining supra-molecular chemistry with on-surface coordination chemistry, the reversible spin switching of self-assembled bi-molecular arrays has recently been demonstrated. [5]

All these examples have in common that the molecular interfaces are well defined by their production from atomically clean substrates and molecular building blocks. The physics and chemistry of these unprecedented systems, which are addressable by scanning probes, provide insight into novel materials in their assembly, their electronic and spintronic properties which emerge from the interaction of their components down to the scale of single atoms, molecules and bonds.

[1] J. Lobo-Checa *et al*. Science 325, 300 (2009).
[2] A. Scheybal *et al*. Chem. Phys. Lett. 411, 214 (2005).
[3] D. Chylarecka *et al*. J. Phys. Chem. Lett. 1, 1408 (2010).
[4] C. Waeckerlin *et al*. Nature Communications 1, 61 (2010), DOI: 10.1038/ncomms1057.
[5] C. Waeckerlin *et al*. Advanced Materials, 25, 2404 (2013), DOI: 10.1002/adma.201204274.

標題：ナノサイエンスセミナー：Laser-induced field emission from a tungsten tip in weak and strong field regime

日時：2013 年 11 月 13 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：柳沢 啓史

所属：ETH, Zurich

要旨：

Applying strong electric fields to a metal enables field emission due to electron tunneling into the vacuum. Field emission from metallic tips with nanometer sharpness has been introduced some time ago as highly bright and coherent electron source. Illuminating such a metallic tip with femtosecond laser pulses realized pulsed field emission with spatio-temporal control with femtosecond and nanometer resolution, and made them attractive for both basic research and new applications1).

To use this technique for applications, emission mechanism has to be understood. The emission mechanism depends on the strength of the laser field. For relatively weak fields, single-electron excitations by single- and multi-photon absorption are prevalent, and photo-excited electrons are tunneling through the surface potential barrier or emitted over the barrier2). On the other hand, the emission mechanism in strong field regime is still controvertial3,4).

Here, we have investigated electron energy distribution curves (EDCs) of the electron emission from a clean tungsten tip apex induced by 7 femtosecond laser pulses. By measuring EDCs with varying laser power, smooth transition from weak field regime to strong field regime was observed. Simulations indicate that electron tunneling driven by modification of surface potential with laser fields is essential to explain the observed data.

1) H. Yanagisawa, *et. al.*, Phys. Rev. Lett. 103, 257603 (2009).
2) H. Yanagisawa, *et. al.*, Phys. Rev. Lett. 107, 087601 (2011).
3) M. Kruger, M. Schenk, and P. Hommelhoff, Nature 475, 78 (2011).
4) G. Herink, D. R. Solli, M. Gulde, and C. Ropers, Nature 483, 190 (2012).

標題：理論インフォーマルセミナー：磁気励起に伴う電気磁気光学効果
日時：2013 年 11 月 14 日(木) 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：宮原 慎
所属：福岡大学
要旨：

近年、磁性秩序と強誘電性が共存する“マルチフェロイックス物質”が相次いで発見され、スピンと電気分極の強い結合について研究がなされている。こうした系では、電気分極とスピンの強い相関を反映し、マグノン励起が特異な光学効果を示すことが期待される。我々は、スピン流機構やスピンに依存する金属-配位子混成機構によって生じる電気磁気相関に着目し、非反転対称磁性体のマグノン励起に関する吸収過程を解析した。その結果、マグノン励起に伴う吸収が非相反的方向二色性(光の吸収強度が波数ベクトルの符号に依存する現象)や自然旋光性を示すことがあることを明らかにした。

【参考文献】
[1] S. Miyahara and N. Furukawa, J. Phys. Soc. Jpn. **80** (2011) 073708.
[2] S. Miyahara and N. Furukawa, J. Phys. Soc. Jpn. **81** (2012) 023712.

標題：理論セミナー：Multiple FFLO Phases Appear in Two-Band Superconductor
日時：2013 年 11 月 15 日(金) 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：高橋 雅裕
所属：学習院大学
要旨：

It has been reported that several materials which have multiple Fermi surfaces being involved in the superconductivity, such as MgB_2 and Iron-based superconductors. For these materials, the multi-band effect will play important roll.

In this study, we focused on the multi-band effect to the Pauli limiting superconductors under external fields. In the high field regime, it is theoretically known that the Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) state with the modulating gap function is stabilized due to the finite center-of-mass momenta of the Cooper pairs.

We start from the microscopic Hamiltonian assuming the existence of the multiple bands. By applying the mean field approximation, we derive the Bogoliubov-de Gennes (BdG) equation and the gap function for the multi-band superconductors. In the formalism, possibility of appearance of the FFLO states are involved through the boundary condition. The multi-band effects are included through the Cooper-pair tunneling between the bands.

From the self-consistent numerical calculations of two-band superconductors, it is found that the FFLO phase is divided into two phases via the first order transition. And one of the phase is further subdivided by successive first order transitions into many --- actually infinitely many --- phases, forming a devil's staircase structure [1].

The derived phase diagram and the mechanism of forming the devil's staircase will be introduced in the presentation.

[1] Takeshi Mizushima, Masahiro Takahashi, and Kazushige Machida, arXiv: 1305.3678.

標題：計算物質科学研究センター 第3回シンポジウム
日時：2013年11月19日(火)～2013年11月20日(水)
場所：物性研究所本館6階 大講義室（A632）
要旨：

物性研究所計算物質科学研究センター(CCMS)は K-computer の利用を念頭に、大規模並列計算による物質科学研究の推進を目的として2011年4月に発足した。とくに第1回(2011年9月)、第2回(2012年10月)のシンポジウムでは、共用法大規模実験施設(J-PARC, SPring-8, SACLA, K-computer)の連携をキーワードとして、実験家も交えた討論を行った。CCMS では、今年度より、元素戦略磁石拠点との連携も深まり、永久磁石の設計に関する研究にも重点をしている。今回は前2回と比べてよりテーマを絞り、「スピン軌道相互作用」とくに「磁気異方性」に関連したトピックスを中心として、実験・理論・計算にまたがる問題について討論する。
詳細ページ：http://www.cms-initiative.jp/ja/events/events_CCMS/sympo11192013

標題：シリーズセミナー：極限コヒーレント光科学　22回目　「Applications of Ultrafast & Nonlinear Spectroscopy: From 2D materials to mimicking neuro-functioning」
日時：2013年11月20日(水)　午前10時30分～
場所：物性研究所本館6階 第1会議室（A636）
講師：ケシャブ ダニ
所属：沖縄科学技術大学院大学　フェムト秒分光法ユニット
要旨：

The Femtosecond Spectroscopy Unit at the newly established Okinawa Inst. of Science and Technology (OIST) studies the applications of ultrafast and nonlinear spectroscopy in a variety of phenomena ranging from opto-electronic properties of two-dimensional materials to mimicking neurotransmitter dynamics of the brain. In this talk, I will present the experimental facilities in femtosecond spectroscopy developed by us at OIST over the past two years. I will then present a broad overview of our recent studies in (i) opto-electronic properties of novel two-dimensional materials, (ii) selection rules and optical manipulation of the pseudo-magnetic properties of graphene quantum dots, and (iii) mimicking neurotransmitter dynamics of the brain using femtosecond pulses.

標題：トポロジカル秩序相としてのスピン液体（新量子相 Lecture Series 第1回）
日時：2013年11月21日(木)　午前10時～午前11時
場所：物性研究所本館6階 第5セミナー室（A615）
講師：押川 正毅
所属：物性理論研究部門
要旨：

絶対零度においても何ら(通常の意味での)秩序を持たない「スピン液体」の提案以来多くの研究が行われて来たが、スピン液体の実現は理論的な模型についてすら苦闘の連続であった。しかし、長年の研究により少なくとも人工的な理論模型ではスピン液体の実現が確立し、またある種のスピン液体はトポロジカル秩序相の一例として記述できることがわかってきた。また、スピン液体の実験的研究も活発に行われている。本講演では、トポロジカル秩序相の観点からスピン液体に関する理論的理解をレビューする。実験家を念頭に、数学的詳細よりも物理的な描像や帰結を中心として議論したい。

標題：理論セミナー：Density functional theory for plasmon-assisted superconductivity
日時：2013 年 11 月 22 日(金) 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：明石 遼介
所属：東京大学大学院工学系研究科
要旨：

One of the most fascinating goals in the studies of superconductivity is the predictive calculation of superconducting transition temperatures (Tc) based on a unified theoretical framework. Since the electron-lattice and electron-electron interactions which cause superconducting transition strongly depend on the electronic and lattice structures, a proper description of the superconducting mechanisms with an accurate treatment of the structures is crucial. For a conventional phonon-induced superconducting mechanism, such a unified framework is established by the recent progress in the density functional theory for superconductors[1] (SCDFT); the current SCDFT-based calculation scheme systematically reproduces Tc observed by experiments in the conventional systems such as niobium and MgB2, with discrepancies no more than a few kelvin. However, further extensions including other mechanisms are essential to treat more general materials.

Recently, we extended the SCDFT-based scheme to include a plasmon mechanism of superconductivity[2]. In dilute uniform electron gas, it has been proposed that plasmon-induced screened dynamical Coulomb interaction induces superconducivity[3]. This mechanism is also expected to become relevant in a wider range of systems because it can cooperate with the conventional phonon mechanism. Our extended scheme enables us to evaluate the effects on Tc of the plasmon and phonon mechanisms on equal footing. In the talk, we present the formulation and the recent application to lithium under high pressures.

The present work is done in collaboration with Prof. Ryotaro Arita.

[1] M. Luders, *et al*., Phys. Rev. B 72, 024545 (2005); M. A. L. Marques *et al*., Phys. Rev. B 72, 024546 (2005).
[2] R. Akashi and R. Arita, Phys. Rev. Lett. 111, 057006 (2013).
[3] Y. Takada, J. Phys. Soc. Jpn. 45, 786 (1978).

標題：理論セミナー：反転対称性の破れとスピン軌道相互作用がもたらす特異な電子状態と非対角応答
日時：2013 年 11 月 26 日(火) 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：楠瀬 博明
所属：愛媛大学大学院理工学研究科
要旨：

空間・時間反転対称性は固体中の電子状態を強く制限するため、これらの破れはその制限を緩め、新しい物性を生み出すと期待される。特に、スピン軌道相互作用は、電気と磁気の性質をつなぐ重要な役割を果たす。

本講演では、蜂の巣格子のような局所的に反転対称性のない系に着目して、反強磁性などの秩序が空間反転対称性の自発的破れを誘発すること、その結果、生じる反対称スピン軌道相互作用もしくは反対称スカラー場が電気磁気効果やスピン伝導などの非対角な応答に特異な影響を及ぼすことを紹介する。特に、蜂の巣格子における 2 軌道ミニマル模型の解析結果を中心に議論したい。

標題：理論インフォーマルセミナー：Electron cooling in superconducting hybrid structures
日時：2013 年 12 月 9 日(月) 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：Andrey S. Vasenko
所属：LPMMC, Université Joseph Fourier and CNRS
要旨：

The long-desired aim in the nanotechnology is to create a structure which can cool down simply by pushing the electric current through it. An example of such a structure is a NIS (Normal metal - Insulator - Superconductor) tunnel junction [1]. The flow of electric current in NIS junctions is accompanied by heat transfer from the normal metal into the superconductor. This phenomenon arises due to selective tunneling of high energy quasiparticles out of the normal metal which is induced by the superconducting energy gap. It is similar to the Peltier effect in metal-semiconductor contacts and enables refrigeration of electrons in the normal metal. Present state-of-the-art experiments allow the reduction of the electron temperature in a normal metal lead from 300 to about 100 mK, offering perspectives for on-chip cooling of nanosized systems, such as high-sensitive detectors and quantum devices [2].

However, there are limitations of the cooling effect resulting from different processes like nonequilibrium quasiparticle injection [3], Andreev tunneling [4], interaction with electromagnetic environment [5], etc. In this talk we discuss how to overcome these limitations by choosing the appropriate superconducting hybrid structure. For example, the Andreev processes can be reduced by introducing the ferromagnetic (F) interlayer in NFIS junction [6] or use alternatively spin-filter interfaces [7]. Finally, we will briefly discuss thermal transport in different superconductor hybrid structures.

[1] J.T. Muhonen, M. Meschke, and J.P. Pekola, Rep. Prog. Phys. **75**, 046501 (2012).
[2] P.J. Lowell, G.C. O'Neil, J.M. Underwood, and J.N. Ullom, Appl. Phys. Lett. **102**, 082601 (2013).
[3] A.S. Vasenko and F.W.J. Hekking, J. Low Temp. Phys. **154**, 221 (2009).
[4] A. S. Vasenko, E. V. Bezuglyi, H. Courtois, and F.W.J. Hekking, Phys. Rev. B **81**, 094513 (2010).
[5] J.P. Pekola, V.F. Maisi, S. Kafanov, N. Chekurov, A. Kemppinen, Yu.A. Pashkin, O.-P. Saira, M. Mottonen, J.S. Tsai, Phys. Rev. Lett. **105**, 026803 (2010).
[6] A. Ozaeta, A.S. Vasenko, F.W.J. Hekking, and F.S. Bergeret, Phys. Rev. B **85**, 174518 (2012).
[7] S. Kawabata, A. Ozaeta, A.S. Vasenko, F.W.J. Hekking, F.S. Bergeret, Appl. Phys. Lett. **103**, 032602 (2013).

標題：シリーズセミナー：極限コヒーレント光科学　23 回目 「誘導ラマン分光顕微鏡による無染色生体組織イメージング」
日時：2013 年 12 月 16 日(月) 午前 10 時 30 分～
場所：物性研究所本館 6 階 大講義室（A632）
講師：小関 泰之
所属：東京大学大学院 工学系研究科 電気系工学専攻
要旨：

生体組織を顕微鏡でそのまま観察すると、多くの場合はほぼ透明である。この透明な生体組織を観察するために、医療現場では薬剤で組織を色づけする染色技術が使われてきた。一方、例えば医療現場における腫瘍の除去手術などにおいては、無染色かつ迅速な組織観察技術が有用となろう。

講演者は、そのような光学顕微観察の一手法として、誘導ラマン散乱(stimulated Raman scattering, SRS)顕微鏡の開発を進めてきた。SRS 顕微鏡では 2 色のピコ秒パルスの一方に強度変調を施した後、生体試料に集光照射する。SRS によってもう一色のパルスに転写された強度変調をロックイン検出することで生体分子のラマン信号を高感度に得て、レーザー走査によりイメージングを行う。

本講演では、SRS 顕微鏡の原理、特長及び研究状況を概観した後、講演者らが最近開発した高速波長可変パルス光源を用いた SRS 分光顕微鏡と、それによる生体組織のマルチカラーイメージングの結果を紹介する。また、SRS 顕微鏡に求められるレーザーについても議論したい。