物性研究所セミナー

標題：理論インフォーマルセミナー：Real-Space and Momentum-Space Entanglement Spectrum of Spin Chains
日時：2013 年 7 月 17 日(水)　午後 4 時～午後 5 時
場所：物性研究所本館 6 階 第 4 セミナー室（A614）
講師：Rex Lundgren
所属：Department of Physics, The University of Texas at Austin
要旨：

We study the entanglement spectrum of the one-dimensional Kugel-Khomskii (KK) model and an anisotropic J_1-J_2 spin-half chain using analytical techniques and exact diagonalization. We compute the entanglement spectra using a variety of partitions or "cuts" of the Hilbert space, including two distinct real-space cuts and a momentum-space cut. Our results show that both models possess a number of new features not previously encountered in studies of the entanglement spectra. Notably for the KK model, we find robust gaps in the entanglement spectra for both gapped and gapless phases with the orbital partition, and show these are not connected to each other. We observe for the KK model the counting of the low-lying entanglement eigenvalues shows that the "virtual edge" picture which equates the low-energy Hamiltonian of a virtual edge, here one gapless leg of a two-leg ladder, to the "low-energy" entanglement Hamiltonian breaks down for this model, even though the equivalence has been shown to hold for similar cut in a large class of closely related models. The momentum space entanglement spectrum for the anisotropic J_1-J_2 spin-half chain reveals that the entanglement gap seen at the Heisenberg point does not remain open for all conformal field theories. In addition, we show that a momentum space cut for the KK model leads to qualitative differences in the entanglement spectrum when compared with the same cut in the gapless spin-1/2 Heisenberg spin chain.

標題：理論セミナー：Computational control of energy scales in the electronic-structure calculations involving f-electrons
日時：2013 年 7 月 19 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：松本　宗久
所属：物質・材料研究機構
要旨：

Recently, progress in ab initio description of correlated materials have been made by the synthesis of electronic-structure calculations and many-body theories. Downfolding scheme to get the realistic multi-orbital Hubbard models have been established for d-electrons [1] with successful applications to iron pnictides, while we have adapted the density functional theory combined with dynamical mean-field theory [2] to materials with localized f-electrons within the framework of realistic Kondo lattice models [3]. We incorporated the orbital degeneracy with local-level splittings imposed by crystal fields and spin-orbit interaction to put the realistic energy scales under computational control and we found novel quantum critical points (QCP's) in a realistic Kondo lattice model for plutonium compounds [4]. Here we inspect how the conduction band renormalization drives the quantum phase transitions and discuss the dual nature of f-electrons between itinerancy and localization in emerging energy

scales near the QCP's. Based on the 2-pole approximation [5] for the self energy, we propose an upfolding scheme to restore the high-energy information for the itinerant-electron bands out of the quasiparticle renomalization factor obtained by quantum Monte Carlo method for the low-energy calculations.

標題：理論インフォーマルセミナー：Shot noise of quasiparticles at local fractional Quantum Hall states
日時：2013 年 7 月 24 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：橋坂　昌幸
所属：東京工業大学 大学院理工学研究科
要旨：

Shot noise in a quantum point contact (QPC) reflects fractional charge of quasiparticles [1] and chiral Luttinger liquid (CLL) nature of edge channels [2] in fractional quantum Hall (QH) regimes. On the other hand, in integer QH regimes, dc current measurements through a QPC suggested quasiparticle tunneling through the constriction region of a "local fractional QH state". Even when bulk filling factor υ_B is an integer, the local filling factor υ_{QPC} can be a fraction, because negative gate voltages modifies the local electron density at the QPC [3]. In this talk, I will show the experimental results for shot noise of fractional quasiparticles at various υ_{QPC} in integer bulk QH regimes. Surprisingly, we observed finite shot noise corresponding to $e/3$ charge of quasiparticles on a well-developed $e^2/(3h)$ conductance plateau. This mechanism can be explained with tunnel coupling between fractional edge channels running parallel in integer QH systems [4].

References:

[1] R. de-Picciotto et al., Nature **389**, 162 (1997); L. Saminadayar et al., Phys. Rev. Lett. **79**, 2526 (1997).
[2] D. C. Glattli et al., Physica E **6**, 22 (2000); Y. C. Chung et al., Phys. Rev. B **67**, 201104(R) (2003).
[3] S. Roddaro et al., Phys. Rev. Lett. **93**, 046801 (2004).
[4] Beenakker, Phys. Rev. Lett. **64**, 216 (1990).

標題：Mini-workshop：Recent topics on magnetism: from permanent magnets to topological materials
日時：2013 年 7 月 31 日(水)　午前 11 時～午後 4 時 50 分
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
要旨：

11:00-12:00　Prof. Oleg Mryasov (Department of Physics and MINT Center, The University of Alabama, Tuscaloosa, AL)
Mechanism of magnetic anisotropy and its temperature dependence

13:30-14:30　小野瀬　佳文 氏（東京大学大学院総合文化研究科）
Berry phase induced Hall effects of electrons and magnons

14:40-15:40　藤本　聡 氏（京都大学大学院理学研究科）
Topological phases in correlated electron systems

15:50-16:50　多々良　源 氏（理化学研究所 創発スピン物性理論研究チーム）
Spin electromagnetic field and its role in spintronics

標題：理論セミナー：Spin liquid phases in strongly correlated lattice models
日時：2013 年 8 月 5 日(月)　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：Sandro Sorella
所属：SISSA, Trieste
要旨：

In the last few years an enormous progress in computer performances and a significative advance in computational techniques are opening a new frontier for the solution of fundamental problems in the physics of strongly correlated systems that has been lacking for too many decades.

We report recent calculations for the Hubbard model on the honeycomb lattice at half filling, for cluster sizes containing up to 2500 sites, much larger than previous simulations [1], ruling out possible spin liquid phases.

We instead show that in a spin model with frustrating interactions a gapless spin liquid phase naturally emerges as the variational ansatz is systematically improved by means of few Lanczos steps [2].

References

[1] S. Sorella, Y. Otsuka and S. Yunoki, Scientific Reports 2, 992 (2012) doi:10.1038/srep00992.
[2] W. Hu, F. Becca, A. Parola and S. Sorella, arXiv:1304.2630 (2013).

標題：LASOR **セミナー：**Electronic properties of iron arsenic high temperature superconductors（**角度分解光電子分光で調べた鉄ヒ素系高温超伝導体の電子状態**）
日時：2013 年 8 月 28 日(水)　午後 1 時 30 分～
場所：物性研究所本館 6 階 第 5 セミナー室（A615）
講師：Pro. Adam Kaminski
所属：Ames Laboratory and Iowa State University, USA
要旨：

Iron arsenic high temperature superconductors exhibit particularly rich and interesting phase diagrams. In $Ba(Fe_{1-x}Co_x)_2As_2$ the simultaneous structural/magnetic phase transition that occurs in the undoped material can be driven to lower temperatures with increased Co substitution. When the transition temperature is sufficiently lowered by carrier doping, the superconductivity emerges. We found that dramatic changes in the Fermi surface coincide with the onset of superconductivity in electron-doped $Ba(Fe_{1-x}Co_x)_2As_2$. The binding energy of both hole and electron bands also changes significantly with temperature in both pure and Ru substituted samples. The hole and electron pockets are well nested at low temperature in unsubstituted $BaFe_2As_2$ samples. Upon warming, this nesting is degraded as the hole pocket shrinks and the electron pocket expands. We also studied the electronic structure of $CaFe_2As_2$ in collapsed tetragonal (CT) phase that is difficult to access for ARPES. By using the post growth, thermal treatment of the single crystals to induce internal strain we were able to stabilize the CT phase at ambient-pressure. We found significant differences in the Fermi surface topology and band dispersion data from the more common orthorhombic-antiferromagnetic or tetragonal-paramagnetic phases, consistent with electronic structure calculations of the two phases. The top of the hole bands sinks below the Fermi level, which destroys the nesting present in parent phases. The absence of nesting in this phase along with apparent loss of Fe magnetic moment, is very likely linked to the lack of superconductivity.

[1] Takeshi Kondo et al., Phys. Rev. Lett. 101, 147003 (2008).
[2] C. Liu et al., Phys. Rev. Lett. 101, 177005 (2008)
[3] Chang Liu, et al., Phys. Rev. Lett. 102, 167004 (2009)

[4] Takeshi Kondo et al., Phys, Rev. B 81, 060507 (2010)
[5] Chang Liu et al., Nature Physics 6, 419-423 (2010)
[6] Chang Liu et al., Phys. Rev. B 84, 020509 (2011)
[7] R. S. Dhaka et al., Physical Review Lett. 107, 267002 (2011)
[8] R. S. Dhaka et al., Phys. Rev. Lett. 110, 067002 (2013)

標題：第 4 回物質・物性セミナー：Anharmonic phonon response of encaged atoms investigated with neutron scattering

日時：2013 年 9 月 2 日(月)　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：Professor Hannu Mutka

所属：Institut Laue Langevin

要旨：

Einstein modes witnessed by bulk thermodynamic data have initiated extensive investigation of low-energy phonon response, so-called 'rattling' modes. This phenomenology has been recently observed in skutterudites, clathrates as well as in β-pyrochlore osmates. Inelastic neutron scattering on powder samples has been applied in the search for microscopic evidence of the Einstein modes as well as their anharmonicity. I shall review the experimental analysis of low-energy vibrational modes associated with the alkali atoms in the β-pyrochlores [1-5] and M atoms in the MxV2Al20 compounds, 'Einstein' solids first reported some 40 years ago and re-examined again recently [6]. The aim is to connect quantitatively the signature of the flat bottom potential seen as the hardening of the characteristic energy scale of the 'rattling' mode with increasing temperature and the corresponding downward, concave curvature in the T-dependence of the atomic displacement parameter .

標題：シリーズセミナー：極限コヒーレント光科学　21 回目　「テラヘルツパルスを用いた BCS 状態のヒッグスモードの観測と光制御」

日時：2013 年 9 月 9 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：松永　隆佑

所属：東京大学大学院 理学系研究科 物理学専攻 島野研究室

要旨：

近年高強度テラヘルツパルス発生技術が著しく進展し、テラヘルツ帯における非線形光学応答や強いテラヘルツ波による物性制御の研究が非常に活発化している。我々は BCS 超伝導状態のテラヘルツ波制御に向けて研究を進めてきた。典型的な金属 BCS 状態の超伝導ギャップのエネルギースケールは meV 程度、つまりテラヘルツ帯にあるため、高強度テラヘルツパルスによって高密度の準粒子を共鳴的に励起することで、余剰エネルギーで格子系を加熱することなく瞬時に非平衡 BCS 状態を実現することができる。テラヘルツ波ポンプ-テラヘルツ波プローブ分光によりオーダーパラメーターの超高速ダイナミクスを調べることが可能である[1]。

最近我々のグループでは、BCS 状態の応答時間よりも短いパルス幅のテラヘルツパルスで瞬時的な摂動を与える、つまり非断熱的に励起を行うことによって、オーダーパラメーターの大きさがコヒーレントに振動する現象を観測することに成功した[2]。これは自発的対称性の破れに伴って出現する「ヒッグスモード」と呼ばれる集団励起モードに相当する。セミナーではこのヒッグスモードの詳細と、ヒッグスモードを利用したオーダーパラメーターのコヒーレント制御の可能性について議論する。

[1] R. Matsunaga and R. Shimano, Phys. Rev. Lett. 109, 187002 (2012).
[2] R. Matsunaga et al., Phys. Rev. Lett. in press. arXiv:1305.0381 [cond-mat.supr-con].