AHMF & Cadet Program Joint Seminar

先端強磁場科学研究センター＆カデットプログラム共催セミナー

講師 (Speaker): Dr. Yasir Iqbal
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日時 (Date & Time): May 31, 2022, 13:30 - 15:00

場所 (Venue): 南部陽一郎ホール (Nambu Yoichiro Hall) & Zoom meeting

タイトル(Title) : Quantum Spin Liquid Physics on a novel shuriken lattice based material

要旨 (Abstract): The search for quantum spin liquids is one of the most hotly pursued endeavors in condensed matter physics. In two-dimensions, corner-sharing triangular geometries such as the kagome lattice have proved to be a fertile ground in realizing these exotic phases of quantum matter. In this talk, I will discuss the novel shuriken lattice geometry as an ideal playground for realizing quantum spin liquids, being motivated by its recent first of a kind experimental realization in the spin $S = 1/2$ system $KCu_6AlBiO_4(SO_4)_5Cl$. Towards understanding the rich quantum phase diagram of Heisenberg spins on the shuriken lattice, we employ state-of-the-art quantum many-body numerical techniques such as variational Monte Carlo (VMC) with versatile Gutzwiller-projected Jastrow wave functions, unconstrained multi-variable variational Monte Carlo (mVMC), and pseudo-fermion/Majorana functional renormalization group (PF/PM-FRG) methods. We establish the presence of a quantum paramagnetic ground state and investigate its nature, by classifying symmetric and chiral quantum spin liquids, and inspecting their instabilities towards competing valence-bond-crystal (VBC) orders. Our VMC analysis reveals that a VBC with a pinwheel structure emerges as the lowest-energy variational ground state, and it is obtained as an instability of the U(1) Dirac spin liquid. Analogous conclusions are drawn from mVMC calculations employing accurate BCS pairing states supplemented by symmetry projectors, which confirm the presence of pinwheel VBC order by a thorough analysis of dimer-dimer correlation functions. Our work highlights the nontrivial role of accounting for further neighbor Heisenberg and/or Dzyaloshinkii-Moriya interactions towards explaining the experimental observations.

Reference: Phys. Rev. B **104**, L220408 (2021), “Pinwheel valence-bond-crystal ground state of the spin-1/2 Heisenberg antiferromagnet on the shuriken lattice”, Nikita Astrakhantsev, Francesco Ferrari, Nils Niggemann, Tobias Müller, Aishwarya Chauhan, Augustine Kshetrimayum, Pratyay Ghosh, Nicolas Regnault, Ronny Thomale, Johannes Reuther, Titus Neupert, Yasir Iqbal

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