Joint CQSE and CASTS Seminar

Interview Talk
Feb. 21, 2014 (Friday)

TIME	Feb. 21, 14:30 ~ 15:30
TITLE	Searching Z2 Resonating Valence Bond Spin Liquid state on a bipartite lattice
SPEAKER	Dr. Ling Wang California Institute of Technology, USA
PLACE	Rm716, CCMS & New Physics Building, NTU

Abstract

Z2 topological spin liquid phase is an exotic state of matter which exhibits nontrivial quasiparticle excitation and braiding statistics. Its classification goes beyond the traditional Ginzburg-Landau paradigm, while its significance ties to the realization of the fault tolerant quantum computing.

The theoretical existence of a Z2 gaped spin liquid on a Kagome Heisenberg model stimulates the classification and understanding of all topological phases of matter in 1 and 2 dimension. However theoretical or experimental search for more concrete examples is still a tough journey. For example, whether such a state exist for the most realistic model, so called the frustrated J1-J2 Heisenberg model on a bipartite lattice, remains a controversial issue. Our focus is to use the resonating valence bond (RVB) ansatz to clarify this issue.

Starting from the short range RVB (SRVB) state, we propose two class of RVB ansatze to study the ground state (GS) of the frustrated J1-J2 AF Heisenberg model on a square lattice. The first class [1] of ansatze build-in diagonal singlet bond and collapse the extensive GS degeneracy of a square SRVB state to four-fold, which realize one of the key factors of the Z2 topological phase. The second ansatz [2] introduces bond-bond correlations to minimize the ground state energy. The optimized wavefunction energy is consistent with the ED and DMRG study on a torus [3] and is competitive with the projective BCS variational results [4]. However energetically favored ansatze both exhibit a power law decay dimer dimer correlations, which is a reminiscence of the square SRVB state, and consequently fail to generate a gap that needed to protect the Z2 topological state. We therefore claim that the ground state of the frustrated J1-J2 AF Heisenberg model on a square lattice is a gapless spin liquid state at the intermediate coupling strength.

[1] L. Wang, D. Poilblanc, Z.-C. Gu, X.-G. Wen and F. Verstraete, Phys. Rev. Lett. 111, 037202 (2013)

[2] L. Wang, to appear on arXiv.

[3] S.-S. Gong, W. Zhu, D.-N. Sheng, O. Motrunich, M. Fisher, arXiv:1311.5962 (2013)

[4] W.-J. Hu, F. Becca, A. Parola and S. Sorella, Phys. Rev. B 88, 060402(R) (2013)

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