Chez Pierre

Presents ...

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MIT Room 4-331

SPECIAL CHEZ PIERRE SEMINAR

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"Valence-bond ground states of isotropic quantum antiferromagnets for universal quantum computation"

The study of quantum spin systems dates back to the early twentieth century and has been an active research field. Quantum computation, on the other hand, is a relatively new research field, of less than three decades of age. In our work, we establish a new connection between the two fields, by showing that a ground state of an isotropic quantum antiferromagnet can be used as a resource for universal quantum computation by measurement on the quantum state. Such measurement-based quantum computation utilizes an initial entangled resource state and proceeds with subsequent single-spin measurements only. However, there were not many known resource states and it was actually shown that they are a rarity. Recent quests for such computational resource states have turned to ground states of short-ranged, preferably two-body, interacting Hamiltonians. In particular, success has been obtained in the family of the Affleck-Kennedy-Lieb-Tasaki (AKLT) isotropic quantum magnet models, in which single quantum-bit operations were shown to be possible. However, single-qubit operations are not enough, and it remained open whether any state in the AKLT family can indeed provide the full capability for universal quantum computation. In this talk, we shall demonstrate that the particular two-dimensional spin-3/2 AKLT state on the honeycomb lattice, known to be a quantum disordered ground state without Neel order, does enable universal quantum computation. Interestingly, this state was constructed not long after the notion of quantum computation started to develop.