Quantum spin liquid: novel quantum phase in a Mott insulator with triangular lattice

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Quantum spin liquids (QSLs) are fluid-like states of quantum spins where its long-range ordered state is destroyed by quantum fluctuations. There have now been observations of such states in some two-dimensional organic Mott insulators with triangular lattice, yet the ground state of QSLs remains elusive. Here we report thermal transport and very high sensitivity magnetic torque measurements of $EtMe_3Sb[Pd(dmit)_2]_2$ and its deuterated compound, both of which are likely to have a QSL ground state[1][2]. A sizable linear temperature dependence of thermal conductivity is clearly resolved in the zero-temperature limit, showing gapless excitation with a long mean free path (~1,000 lattice distances). Such a long mean free path demonstrates a novel feature of QSL as a quantum-condensed state with long-distance coherence [2]. In both compounds the magnetic susceptibility remains finite down to low temperatures (30 mK) and magnetization increases nearly linearly up to high field (35 T). These provide direct evidence of the prevailing gapless magnetic excitations, revealing that a ground state of this system is an algebraic spin liquid, where there is no spin-gap and spin-spin correlations decay as a power law. Moreover, the fact that similar behavior is observed in both compounds with different degree of frustration implies the presence of an extended quantum critical phase where the algebraic liquid state is stabilized. These findings of interacting critical phase in two-dimensional quantum magnets point towards important implications for the presence of a novel quantum state near the Mott transition [3].

[1] M. Yamashita *et al.*, Nature Physics 5, 44 (2009).
[2] M. Yamashita *et al.*, Science 328, 1246 (2010).
[3] D. Watanabe *et al.*, Nature Commun. 3, 1090 (2012).