Understanding the detail nature of electrons near a Mott insulating transition, where strong electron-electron Coulomb repulsions play a major role, is a central issue of modern physics. In particular, a novel quantum state of spins, so called quantum spin liquids (QSLs) where spins remain a fluid-like state down to the zero temperature, is proposed to exist near Mott insulator transitions when the quantum spins are subject to geometrical frustration. Organic charge-transfer salts offer us unique opportunity to study the issue because, in many organic molecules, fine band-width control is available near the metal to Mott insulator transitions due to its high degree of freedom of chemical substitution. In fact, promising candidates of QSL have been found in \(\kappa\)-(BEDT-TTF)\(_2\)Cu\(_2\)(CN)\(_3\) and EtMe\(_3\)Sb[Pd(dmit)\(_2\)]\(_2\). Both materials have two-dimensional triangular lattice structure of spins, and the NMR measurements have reported that there is no long-range order of spins down to very low temperature, whereas the nature of the QSL has remained elusive, especially about the magnetic properties and phase diagram, i.e. whether the ground state is spin gapped or gapless and how it varies with frustration.

From highly sensitive magnetic torque measurements down to very low temperature (30 mK) up to high field (32 T), we show that the QSL in EtMe\(_3\)Sb[Pd(dmit)\(_2\)]\(_2\) in the zero-temperature limit presents a finite residual paramagnetic (i.e. Pauli) susceptibility, a hallmark of itinerant fermions in the Mott insulator. This residual susceptibility demonstrates the absence of spin gap, indicating that the ground state of this system is a gapless (algebraic) QSL where spin-spin correlations have anomalous (non-exponential) spatial dependence with infinite correlation length. Moreover, the result is robust against deuteration, pointing toward the emergence of a quantum critical phase in which the spins of electrons remain mobile while the charges are frozen.

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