Coexistence of localized- and itinerant-gapless excitations in spin liquid of 1T-TaS_2

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Quantum spin liquid (QSL) is a state of matter where strong quantum fluctuations destroy the long-range magnetic order even at zero temperature. In two-dimensional triangular lattice antiferromagnet, such as organic insulators, possible QSL states have been reported. However, detailed properties remain unclear due to lattice distortion and strong spin-orbit coupling.

Recently, 1T-TaS_2 is proposed as an ideal material for QSL [1]. It becomes commensurate charge-density wave state and Mott-insulating state below 60 K, in which S=1/2 spin is localized on a center of cluster composed of 13 Ta atoms and arranged on perfect triangular lattice. NQR and μSR reveal the absence of magnetic order down to 70 mK [2].

We performed the measurements of thermal conductivity κ and specific heat C to study low-energy quasiparticle excitations. κ/T and C/T show residual term as $T \rightarrow 0$, demonstrating the presence of highly mobile gapless excitations. Remarkably, an external magnetic field strongly suppresses residual term of C/T whereas it enhances that of κ/T. This unusual contrasting behavior in the field dependence of specific heat and thermal conductivity can be accounted for by the presence of two types of gapless excitations with itinerant and localized characters, as recently predicted theoretically [3]. This unique feature of 1T-TaS2 provides new insights into the influence of quenched disorder on the QSL.

References

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