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Microscopic Evidence of Field-Induced Critical Spin-Liquid State in a Metallic Frustrated Compound

A field-induced quantum spin liquid (QSL) state is an extraordinary phenomenon, hitherto unobserved in metallic frustrated compounds. CePdAl (CPA), a magnetically frustrated metallic compound with a kagome lattice, presents a unique opportunity to explore this phenomenon~\cite{Kitazawa1994}. Recent bulk measurements have revealed intriguing magnetic states in CPA when a magnetic field is applied along the crystallographic c-axis~\cite{Lucas2017}. However, the nature of these field-induced states, potentially including a QSL state, remains unclear due to the lack of microscopic investigation. To elucidate these field-induced states, we employed the transverse-field muon spin relaxation/rotation (TF-μSR) technique, applying various magnetic fields parallel to the c-axis in single-crystalline CePdAl over a broad temperature range (100~K-100~mK). Our findings indicate that field-induced low-temperature states for fields B$\leq$ B_{c2} exhibit long-range magnetic order, whereas for B>B_{c2} yield contrasting behavior. Notably, at 3.75 T, near a critical field B_{c2}, our results provide evidence of a critical spin liquid (CSL) with antiferromagnetic spin fluctuations. Furthermore, at 4.3 T, a non-Fermi liquid state is observed where frustration is absent. This comprehensive microscopic study unequivocally establishes the existence of a CSL state in a metallic frustrated system.

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