

NMR in high magnetic fields and low temperatures: a study of quantum magnetism in m-NO₂PhBNO and Ce₃Pd₂₀Si₆

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Quantum magnetic systems with reduced dimensionality provide exceptional platforms for studying field-induced quantum phase transitions and the universal critical behavior. However, due to the underlying quantum nature, these phenomena frequently require high magnetic fields and low temperatures, which makes comprehensive studies challenging. Here, we investigate a quasi-one-dimensional Haldane system m-NO₂PhBNO (BoNO) and a cubic heavy-fermion compound Ce₃Pd₂₀Si₆ (CPS) using nuclear magnetic (NMR) and quadrupolar resonance (NQR) to reveal their low-temperature phase diagrams.

BoNO constitutes a novel approach to designing low-dimensional quantum magnets with readily accessible collective phases ($B_{c1} = 1$ T, $B_{c2} = 34$ T, $T_{N,max} = 3.3$ K). Owing to its purely organic composition, BoNO exhibits remarkable magnetic isotropy, as corroborated by extensive magnetic susceptibility, ESR and NMR data. We present a complete phase diagram, determine the critical exponent ν at B_{c2} , and validate the theoretical framework across the Tomonaga-Luttinger regime, Bose-Einstein condensate phase, and quantum critical region. These findings are further supported by state-of-the-art computational methods, including density matrix renormalization group and quantum Monte Carlo simulations.

CPS presents a heavy-fermion system with high $Fm\bar{3}m$ symmetry, featuring two distinct Ce $4f$ magnetic moments. Neutron scattering data reveal two successive transitions into an antiferroquadrupolar ($T_Q = 470$ mK) and an antiferromagnetic ($T_N = 250$ mK) phase. Our ¹⁰⁵Pd NQR measurements shed light on the magnetic structure and the spin dynamics at dilution refrigerator temperatures down to 50 mK. We find no evidence of conventional magnetic order, although the NMR relaxation data suggests a possible onset of Kondo screening in the system. CPS also exhibits a Kondo-breakdown quantum critical point, where suppression of magnetic order coincides with a Fermi surface reconstruction. However, field-dependent NMR data do not corroborate this scenario, suggesting the absence of static magnetic order in CPS on the NMR experimental timescale.