Magnetization Study of the Quantum Critical Behavior of the One Dimensional Spin-1/2 Heisenberg Antiferromagnet CuPzN

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One dimensional (1D) S = 1/2 Heisenberg antiferromagnets (HAFs) provide a simple example of field-induced quantum criticality. At a critical field $H_c = 2J/g\mu_B$, where J is the intrachain interaction, the systems undergo a quantum phase transition at $T = 0$ from a gapless Tomonaga-Luttinger liquid ($H < H_c$) to a gapped saturated state ($H > H_c$). Although this transition has been extensively studied theoretically [1], not much experimental work has been done on the behavior of magnetization near the quantum critical point (QCP). In this contribution, we present high-precision magnetization data on copper pyrazine dinitrate (CuPzN), one of the best realizations of 1D S = 1/2 HAF [2]. The relatively small coupling constant J = 10.3 K of this compound allows us to examine the detailed behavior of magnetization near the QCP in a static, non-pulsed magnetic field. We have performed DC magnetization (M) measurements on a single crystal of CuPzN in magnetic fields H (|| b axis) up to 15 T at temperatures down to 80 mK. At the base temperature, full saturation of M is observed above H_c = 14 T with the $M(H)$ curve closely following a prediction based on the Bethe ansatz [1]. The peak in $M(T)$, which appears at about 7 K in the limit of $H = 0$, moves to low temperatures with increasing H and vanishes into a temperature region well below 80 mK at $H = H_c$; as a result, $M(T)$ exhibits a strong upturn as $T \to 0$ at this field, in agreement with a theoretical prediction [3]. These results constitute an observation of field-induced quantum critical behavior in bulk magnetization.

References

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